



LONDON- WEST MIDLANDS ENVIRONMENTAL STATEMENT

Volume 5 | Technical Appendices

CFA13 | Calvert, Steeple Claydon, Twyford and Chetwode
Water resources assessment (WR-002-013)
Water resources

November 2013

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Department for Transport

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1 Introduction

1.1 Structure of the water resources and flood risk assessment appendices

- 1.1.1 The water resources and flood risk assessment appendices comprise several parts. The first of these is a route-wide appendix (Volume 5: Appendix WR-001-000).
- 1.1.2 Specific appendices for each community forum area (CFA) are also provided. For the Calvert, Steeple Claydon, Twyford and Chetwode area (CFA13) these are:
 - a water resources assessment (i.e. this appendix);
 - a flood risk assessment (Appendix WR-003-013); and
 - a hydraulic modelling report for the Padbury Brook (Volume 5: Appendix WR-004-004).
- 1.1.3 Maps referred to throughout the water resources and flood risk assessment appendices are contained in the Volume 5, Water Resources and Flood Risk Assessment Map Book.

1.2 Study area

- 1.2.1 The Proposed Scheme through this area will be approximately 10km in length. It will commence at the western edge of Sheephause Wood, to the south of Calvert, and then proceed in a north-west direction parallel to the realigned Aylesbury Link railway line. It will then pass to the east of Calvert, under the realigned Bicester to Bletchley Line, then west of Steeple Claydon, broadly following the alignment of the disused Great Central Main Line railway.

The Calvert infrastructure maintenance depot (IMD) will be located in the land adjacent to the route, north-east of the Bicester to Bletchley Line crossing, and the associated tracks will run west to east alongside the Bicester to Bletchley Line for approximately 3km, approximately 600m south of Steeple Claydon. The IMD will cover approximately 37ha of land, and will operate as a permanent base for maintenance activities to support the railway infrastructure. Additionally, it will be used as a railhead during the construction phase – for details of construction phasing at the IMD refer to Figure 7, Volume 2, CFA Report 13, Section 2.
- 1.2.2 The spatial scope of the assessment was based upon the identification of surface water and groundwater features within 1km of the centre line of the route, except where there is clearly no hydraulic connectivity. For surface water features in urban areas, the extent was reduced to 500m. Outside of these distances it is unlikely that direct impacts upon the water environment will be attributable to the Proposed Scheme. Where works extend more than 200m from the centre line, for example at stations and depots, professional judgement has been used in selecting the appropriate limit to the extension in spatial scope

required. For the purposes of this assessment this spatial scope is defined as the study area.

1.2.3 The main environmental features of relevance to water resources include:

- the Padbury Brook ,which is an ordinary watercourse in the study area becoming main river downstream at Padbury, its tributaries and associated floodplains;
- Calvert Jubilee Local Wildlife Site (LWS) and Grebe Lake;
- the Glaciofluvial Deposits, Kellaways Formation and the Cornbrash Formation Secondary A aquifers; and
- springs in the vicinity of Barton Hartshorn.

1.2.4 Key environmental issues relating to water resources include:

- potential short term impacts on surface water flows and quality as a result of construction works on and over the Padbury Brook and tributaries; and
- the risk of leachate being encountered during excavations close to Calvert Landfill (see Land Quality: Volume 2, CFA Report 13, Section 8).

2 Stakeholder engagement

2.1.1 Discussions have been held with the following stakeholders to inform the water resources assessment:

- the Environment Agency;
- Buckinghamshire County Council;
- the Bedford Group of Internal Drainage Boards¹ (IDB); and
- the Cherwell and Aylesbury Vale District councils who have confirmed they have no records of unlicensed groundwater abstractions.

¹ The route passes through the management areas of the Buckingham and River Ouse Internal Drainage Board, which is a member of the Bedford Group of Internal Drainage Boards. Land drainage is managed by the Bedford Group of Internal Drainage Boards at Calvert, Steeple Claydon, Twyford, Godington and Newton Purcell and the route will cross the Padbury Brook and its tributaries which are subject to Bedford Group of Internal Drainage Board's statutory and byelaw control.

3 Baseline data

3.1 General

- 3.1.1 The following sub-sections provide a current description of water resources within the study area including surface water and groundwater features.
- 3.1.2 All water bodies in this area fall within the Upper and Bedford Ouse catchment, which includes the Padbury Brook and its tributaries, of the Anglian River Basin District as defined under the Water Framework Directive² (WFD) and are covered by the River Basin Management Plan³ (RBMP).

3.2 Surface water

- 3.2.1 All surface water features within 1km of the route are presented in Table 1. The Calvert IMD will extend eastwards along the existing Bicester to Bletchley Line.
- 3.2.2 The current surface water baseline and water features with codes listed in Table 1 are shown in Maps WR-01-018 and WR-01-019 (Volume 5, Water Resources and Flood Risk Assessment Map Book). If the feature has a specific reference number then this is provided (e.g. a surface water crossing will be referenced as SWC-CFA13-01). If the feature has no specific reference its location on a specific map is provided (e.g. WR-01-018, D6) where D6 is a grid reference using the map specific grid.
- 3.2.3 The surface water features are based on the Environment Agency's Detailed River Network (DRN) with the addition of water bodies noted on the Ordnance Survey's (OS) 'OS VectorMapDistrict'.

² European Parliament and European Council (2000). *Water Framework Directive - Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy*, Strasbourg, European Parliament and European Council.

³ Environment Agency (2009) *River Basin Management Plan, Anglian River Basin District*.

Table 1: Surface water features within 1km of the route in the study area

Water feature	Location description (Volume 5, Water Resources and Flood Risk Assessment Map Book map reference)	Watercourse classification ⁴	WFD water body and current overall status	WFD status objective (by 2027 as in RBMP)	Receptor value ⁵	Q95 ⁶ (m ³ /s)	Catchment area at crossing (km ²)	Notes
Pond	An isolated field pond approximately 150m east of the route between Decoypond Wood and Sheephouse Wood. (CFA13-Po1)	Not applicable	Not applicable	Not applicable	Low	Not applicable	Not applicable	The pond is not connected to any other surface water features in the catchment.
Three ponds	Field ponds approximately 480m east of the route near Shrubs Wood on the CFA12/CFA13 boundary. (CFA13-Po2)	Ordinary watercourse	No status class shown in RBMP – assumed status Good	No status class shown in RBMP – assumed status Good potential (by 2015)	Moderate	Not applicable	Not applicable	The ponds appear to be connected by field drains, which may be linked to the tributary drains of the Twin further north.
Unnamed drain	A drain on the western and southern perimeters of Calvert landfill site extending up to 1km west of the route.	Not applicable	Not applicable	Not applicable	Low	Not applicable	Not applicable	The drain appears to be connected to a group of ponds (CFA13-Po3). These do not appear to be connected to any other surface water features.
Six ponds and watercourse	A network of unnamed ponds and drains to the south and north of Calvert from 250m west of the route up to 1km.	Not applicable	Not applicable	Not applicable	Low	Not applicable	Not applicable	About six ponds (potentially recreational) with interconnecting drains near Calvert. Not connected to any

⁴ Water-feature classifications: Section 113 of the Water Resources Act 1991 defines a main river as a watercourse that is shown as such on a main river map. Section 72 of the Land Drainage Act 1991 defines an ordinary watercourse as 'a watercourse that is not part of a main river'. Section 221 of the Water Resources Act 1991 defines a watercourse as including 'all rivers and streams, ditches, drains, cuts, culverts, dikes, sluices, sewers (other than public sewers) and passageways through which water flows'. Main rivers are larger rivers and streams designated by the Department for Environment, Food and Rural Affairs (Defra) on the main river map and are regulated by the Environment Agency

⁵ For examples of receptor value, see Table 43 in the Scope and Methodology Report (SMR) Addendum, Volume 5: Appendix CT-001-000/2.

⁶ Derived from National River Flow Archive data and catchment areas calculated using the Flood Estimation Handbook - Centre for Ecology and Hydrology, (2009) Flood Estimation Handbook (FEH) CD-ROM Version 3.0. Q95 is the flow which is exceeded for 95% of the time (i.e. it is a low flow and the river will only have flows less than this for 5% of the time).

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Water feature	Location description (Volume 5, Water Resources and Flood Risk Assessment Map Book map reference)	Watercourse classification ⁴	WFD water body and current overall status	WFD status objective (by 2027 as in RBMP)	Receptor value ⁵	Q95 ⁶ (m ³ /s)	Catchment area at crossing (km ²)	Notes
	(CFA13-Po3)							other surface watercourses.
Drain identified by the IDB as M24	To the south of Steeple Claydon, upstream of the Twin. M24 will be crossed by the Calvert IMD and railhead at SWC-CFA13-16.	Ordinary watercourse	No status class shown in RBMP – assumed status Good	No status class shown in RBMP – assumed status Good potential (by 2015)	Moderate	0.0007	4.9	Originates in the grounds of Claydon House. Connects to the Twin.
Drain identified by the IDB as M23	Located south-west of Steeple Claydon, 1km south-west of SWC-CFA13-16. M23 will be crossed by the Calvert IMD and railhead at SWC-CFA13-15.	Ordinary watercourse	No status class shown in RBMP – assumed status Good	No status class shown in RBMP – assumed status Good potential (by 2015)	Moderate	0.0007	1.1	The M23 watercourse flows to the north/north-west to connect with a tributary of the Twin, and eventually flow into the Padbury Brook to the north of Steeple Claydon.
Tributary to the drain identified by the IDB as M23	A tributary of M23, crossed near Brickhill Way, Calvert, by the route at SWC-CFA13-12.	Ordinary watercourse	No status class shown in RBMP – assumed status Good	No status class shown in RBMP – assumed status Good potential (by 2015)	Moderate	Not applicable	Not applicable	The watercourse appears to start at the crossing point on the edge of Calvert.
Pond	An isolated pond approximately 60m west of the route near Calvert. (CFA13-Po4)	Not applicable	Not applicable	Not applicable	Low	Not applicable	Not applicable	The pond is not connected to any other surface water features.
Grebe Lake	Located to the north of Calvert and to the west of the route.	Not applicable	Not applicable	Not applicable	Moderate	Not applicable	Not applicable	Former brick pit now part of LWS. Does not appear to be connected to any other surface

Water feature	Location description (Volume 5, Water Resources and Flood Risk Assessment Map Book map reference)	Watercourse classification ⁴	WFD water body and current overall status	WFD status objective (by 2027 as in RBMP)	Receptor value ⁵	Q95 ⁶ (m ³ /s)	Catchment area at crossing (km ²)	Notes
								water feature.
Lake (Calvert Jubilee LWS)	Calvert Jubilee LWS, located to the north of Calvert between Grebe Lake and the Proposed Scheme. Outflow via drain to M23.	Ordinary watercourse	No status class shown in RBMP – assumed status Good	No status class shown in RBMP – assumed status Good potential (by 2015)	Moderate	Not applicable	Not applicable	Former brick pit now part of LWS. Lies to the east of Grebe Lake. The lake outflows eastwards into a drain that connects to the Twin.
Tributary to the drain identified by the IDB as M23	A pond and tributary to the M23 drains which originate in Calvert Jubilee LWS lake. (SWC-CFA13-01, SWC-CFA13-13 and SWC-CFA13-14)	Ordinary watercourse	No status class shown in RBMP – assumed status Good	No status class shown in RBMP – assumed status Good potential (by 2015)	Moderate	Not applicable	Not applicable	Outflow from lake with existing crossing of Aylesbury Link railway line at SWC-CFA13-01. Flows north-east and joins the Twin, a tributary of the Padbury Brook.
Watercourse S75	Located near Portway Farm (SWC-CFA13-02, SWC-CFA13-17, SWC-CFA13-18 and SWC-CFA13-20)	Ordinary watercourse	No status class shown in RBMP – assumed status Moderate	No status class shown in RBMP – assumed status Good potential (by 2015)	Moderate	0.0006	1.02	The drain flows north/north-east and will be crossed by the route near Portway Farm. The drain passes through an existing culvert under the Bicester to Bletchley Line at SWC-CFA13-17 and joins the Padbury Brook to the east of Three Bridge Mill.
Three ponds	Three isolated ponds approximately 210m - 620m west of the route, near Portway Farm. (CFA13-P05)	Not applicable	Not applicable	Not applicable	Low	Not applicable	Not applicable	The ponds are not connected to any other surface water features.
Two ponds	Two isolated ponds approximately 900m north of the route. Near Briarhill.	Not applicable	Not applicable	Not applicable	Low	Not applicable	Not applicable	The ponds are not connected to any other surface water

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Water feature	Location description (Volume 5, Water Resources and Flood Risk Assessment Map Book map reference)	Watercourse classification ⁴	WFD water body and current overall status	WFD status objective (by 2027 as in RBMP)	Receptor value ⁵	Q95 ⁶ (m ³ /s)	Catchment area at crossing (km ²)	Notes
	(CFA13-Po6)							features.
Unnamed drain	Located approximately 950m north of the route and to the east of Briarhill	Ordinary watercourse	No status class shown in RBMP – assumed status Moderate	No status class shown in RBMP – assumed status Good potential (by 2015)	Moderate	Not applicable	Not applicable	Unnamed field drain approximately 950m north of the route to the east of Briarhill which runs north directly into the Padbury Brook.
Pond	Located near Lake Farm. Isolated pond approximately 450m east of the route. (CFA13-Po7)	Not applicable	Not applicable	Not applicable	Low	Not applicable	Not applicable	The pond is not connected to any other surface water features in the catchment.
Pond	An isolated pond approximately 600m north of the route near Three Bridge Mill. (CFA13-Po8)	Not applicable	Not applicable	Not applicable	Low	Not applicable	Not applicable	The pond is not connected to any other surface water features in the catchment.
Four ponds	Four isolated ponds adjacent to and within 100m north of the route near Twyford Sewage Treatment Works. (CFA13-Po9, SWC-CFA13-19 and SWC-CFA13-21)	Not applicable	Not applicable	Not applicable	Low	Not applicable	Not applicable	The ponds are not connected to any other surface water features in the catchment.
Fourteen ponds	Numerous isolated ponds surrounding the Twyford area from 150m - 850m south of the route.	Not applicable	Not applicable	Not applicable	Low	Not applicable	Not applicable	The ponds are not connected to any other surface water features in the catchment.

Water feature	Location description (Volume 5, Water Resources and Flood Risk Assessment Map Book map reference)	Watercourse classification ⁴	WFD water body and current overall status	WFD status objective (by 2027 as in RBMP)	Receptor value ⁵	Q95 ⁶ (m ³ /s)	Catchment area at crossing (km ²)	Notes
	(CFA13-P10)							
Drain S76	The drain is located near Twyford and will be crossed by the route at SWC-CFA13-03	Ordinary watercourse	No status class shown in RBMP – assumed status Moderate	No status class shown in RBMP – assumed status Good potential (by 2015)	Moderate	0.002	3.64	The drain will be crossed by the route near Twyford. The drain joins the Padbury Brook north of the route, near Three Bridge Mill.
Padbury Brook	Padbury Brook north of Twyford (SWC-CFA13-04) and north-east of Godington (SWC-CFA13-08 and SWC-CFA13-09)	Main river	Padbury Brook (The Twins) Moderate	Good potential (by 2015)	High	0.045 (SWC-CFA13-04) 0.042 (SWC-CFA13-08) 0.036 (SWC-CFA13-09)	73.82 (SWC-CFA13-04) 67.79 (SWC-CFA13-08) 58.88 (SWC-CFA13-09)	The main channel of the Padbury Brook will be crossed by the route three times due to its meandering nature. It will be crossed by the route north of Twyford (SWC-CFA13-04), and twice to the north-east of Godington by the Godington viaducts (SWC-CFA13-08 and SWC-CFA13-09). The Padbury Brook is deemed to be heavily modified as a result of hydromorphological pressures in the area. It flows to the east and then north at Steeple Claydon before joining the River Great Ouse near Buckingham.
Unnamed drain	An unnamed drain running parallel to Padbury Brook close to SWC-CFA13-04 (SWC-CFA13-05)	Ordinary watercourse	No status class shown in RBMP – assumed status Moderate	No status class shown in RBMP – assumed status Good potential	Moderate	0.00001	0.61	The drain joins the Padbury Brook north of the route, near Three Bridge Mill.

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Water feature	Location description (Volume 5, Water Resources and Flood Risk Assessment Map Book map reference)	Watercourse classification ⁴	WFD water body and current overall status	WFD status objective (by 2027 as in RBMP)	Receptor value ⁵	Q95 ⁶ (m ³ /s)	Catchment area at crossing (km ²)	Notes
				(by 2015)				
Three ponds	Three isolated ponds at Cowley Farm and approximately 700m north of the route. (CFA13-P11)	Not applicable	Not applicable	Not applicable	Low	Not applicable	Not applicable	The ponds are not connected to any other surface water features in the catchment.
Unnamed drain	An unnamed drain (tributary of Padbury Brook) flowing south and will be crossed by the route near Twyford. (SWC-CFA13-06)	Ordinary watercourse	No status class shown in RBMP – assumed status Moderate	No status class shown in RBMP – assumed status Good potential (by 2015)	Moderate	0.0003	0.61	This drain joins another drain south of the route, and eventually the Padbury Brook north of the route, near Three Bridge Mill.
Unnamed drain	An unnamed drain (tributary of Padbury Brook) flowing south-west. It will be crossed by the route to the east of Godington. (SWC-CFA13-07)	Ordinary watercourse	No status class shown in RBMP – assumed status Moderate	No status class shown in RBMP – assumed status Good potential (by 2015)	Moderate	0.00001	0.5	The drain joins another drain south of the route, and eventually the Padbury Brook north of the route, near Three Bridge Mill.
Unnamed drain	An unnamed drain at Moat Farm	Ordinary watercourse	No status class shown in RBMP – assumed status Moderate	No status class shown in RBMP – assumed status Good potential (by 2015)	Moderate	Not applicable	Not applicable	The drain connects to the Padbury Brook to the north-east of Moat Farm.
Pond	Approximately 40m south of the route between Padbury Brook and the disused railway.	Not applicable	Not applicable	Not applicable	Low	Not applicable	Not applicable	The pond is not connected to any other surface water features in the catchment.

Water feature	Location description (Volume 5, Water Resources and Flood Risk Assessment Map Book map reference)	Watercourse classification ⁴	WFD water body and current overall status	WFD status objective (by 2027 as in RBMP)	Receptor value ⁵	Q95 ⁶ (m ³ /s)	Catchment area at crossing (km ²)	Notes
	(CFA13-P12)							
Unnamed drain	An unnamed drain flowing east and crossed by the route, north-east of Godington. (SWC-CFA13-10)	Ordinary watercourse	No status class shown in RBMP – assumed status Moderate	No status class shown in RBMP – assumed status Good potential (by 2015)	Moderate	0.00002	0.5	The drain joins the Padbury Brook north of the route, to the east of Godington.
Two ponds	Two field ponds at approximately 800m and 950m west of the route, near Moat Farm. (CFA13-P13)	Not applicable	Not applicable	Not applicable	Low	Not applicable	Not applicable	The ponds are not connected to any other surface water features in the catchment.
Moat	An unnamed moat approximately 750m west of the route, on Moat Farm. (CFA13-P14)	Not applicable	Not applicable	Not applicable	Moderate	Not applicable	Not applicable	The moat is situated immediately south of Padbury Brook and includes a pond.
Lake	An unnamed lake approximately 750m west of the route near Moat Farm. (CFA13-P14)	Not applicable	Not applicable	Not applicable	Moderate	Not applicable	Not applicable	The lake is situated between two channels of the Padbury Brook. The lake does not appear to be connected to the two channels.
Lake	An unnamed lake approximately 400m north of Moat Farm and immediately west of the former Great Central Main Line railway (200m west of the route).	Not applicable	Not applicable	Not applicable	Moderate	Not applicable	Not applicable	The lake has a drain running along the western edge and does not appear to be connected to the tributary of the Padbury Brook

Water feature	Location description (Volume 5, Water Resources and Flood Risk Assessment Map Book map reference)	Watercourse classification ⁴	WFD water body and current overall status	WFD status objective (by 2027 as in RBMP)	Receptor value ⁵	Q95 ⁶ (m ³ /s)	Catchment area at crossing (km ²)	Notes
Unnamed drain	Located approximately 750m west of the route flowing to the south through Barton Grounds Farm and Watergate Farm.	Ordinary watercourse	No status class shown in RBMP – assumed status Moderate	No status class shown in RBMP – assumed status Good potential (by 2015)	Moderate	Not applicable	Not applicable	The drain eventually joins the Padbury Brook near Godington.
Two ponds	Two isolated field ponds approximately 65m and 195m east of the route on Rosehill Farm. (CFA13-P15)	Not applicable	Not applicable	Not applicable	Low	Not applicable	Not applicable	The ponds are not connected to any other surface water features in the catchment.
Two ponds	Two isolated field ponds approximately 100m east of the route near The Hermitage and Chetwode. (CFA13-P16)	Not applicable	Not applicable	Not applicable	Low	Not applicable	Not applicable	The ponds are not connected to any other surface water features in the catchment.
Two moats	Two unnamed moats approximately 100m and 200m east of the route in Chetwode. (CFA13-P17)	Not applicable	Not applicable	Not applicable	Low	Not applicable	Not applicable	Unnamed moats (potentially dry). Not connected to any other surface water features in the catchment.
Pond and watercourse	A pond and drain approximately 270m east of the route within Chetwode. (CFA13-P18)	Ordinary watercourse	No status class shown in RBMP – assumed status Moderate	No status class shown in RBMP – assumed status Good potential	Moderate	Not applicable	Not applicable	The outflow from the pond is linked to a tributary of the Padbury Brook via a drain running east.

Water feature	Location description (Volume 5, Water Resources and Flood Risk Assessment Map Book map reference)	Watercourse classification ⁴	WFD water body and current overall status	WFD status objective (by 2027 as in RBMP)	Receptor value ⁵	Q95 ⁶ (m ³ /s)	Catchment area at crossing (km ²)	Notes
				(by 2015)				
Two moats	Chetwode Moats approximately 650m east of the route. (CFA13-P19)	Ordinary watercourse	No status class shown in RBMP – assumed status Moderate	No status class shown in RBMP – assumed status Good potential (by 2015)	Moderate	Not applicable	Not applicable	Assumed to be connected to a drain to the west of the moats. The drain flows to the Padbury Brook.
Pond	An isolated pond approximately 470m west of the route on Barton Hill Farm. (CFA13-P20)	Not applicable	Not applicable	Not applicable	Low	Not applicable	Not applicable	The pond is not connected to any other surface water features in the catchment.
Unnamed drain	The drain flows west from Barton Hartshorn and will be crossed by the route at SWC- CFA13-11 and by access road at SWC-CFA13-22.	Ordinary watercourse	No status class shown in RBMP – assumed status Moderate	No status class shown in RBMP – assumed status Good potential (by 2015)	Moderate	0.002	3.18	Tributary of Padbury Brook drain flowing west from Barton Hartshorn.
Two ponds	Two field ponds at approximately 550m and 800m east of the route, near Barton Hartshorn. (CFA13-P21)	Not applicable	Not applicable	Not applicable	Low	Not applicable	Not applicable	The ponds do not appear to be in connectivity with any other surface water features in this catchment.
Three ponds	Three isolated field ponds within 50 - 250m west of the route, to the north of Barton Hill Farm.	Not applicable	Not applicable	Not applicable	Low	Not applicable	Not applicable	There is no evidence to suggest that these ponds are in connectivity with a drain that runs adjacent to the ponds.

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Water feature	Location description (Volume 5, Water Resources and Flood Risk Assessment Map Book map reference)	Watercourse classification ⁴	WFD water body and current overall status	WFD status objective (by 2027 as in RBMP)	Receptor value ⁵	Q95 ⁶ (m ³ /s)	Catchment area at crossing (km ²)	Notes
	(CFA13-P22)							
Unnamed drain	The drain runs south along the CFA13/CFA14 boundary near Home Farm.	Ordinary watercourse	No status class shown in RBMP – assumed status Moderate	No status class shown in RBMP – assumed status Good potential (by 2015)	Moderate	Not applicable	Not applicable	The route will cross this watercourse in CFA14 and as such it is not assessed here further. The drain eventually flows into the Padbury Brook near Godington.

3.2.4 According to Environment Agency records⁷, there is one licensed surface water abstraction within the study area which is potentially linked to another licence approximately 1.3km from the route (see Map WR-01-019 in Volume 5, Water Resources and Flood Risk Assessment Map Book). Table 2 summarises the details of these licenses. No unlicensed surface water abstractions were identified within 1km of the route. There is the potential for unlicensed abstractions to exist that have not been identified, as a licence is not required for abstraction volumes below 20m³ per day.

Table 2: Licensed surface water abstractions

Licence identifier (map reference number and Environment Agency reference)	Distance and direction from route (m)	Abstraction source	Maximum annual abstraction quantity (m ³)	Maximum daily abstraction quantity (m ³ /d)	Purpose
SWB4 6/33/02/*S/0125	135m (south-west)	Drain	4,550	436	Spray irrigation
SWB3 6/33/02/*S/0125	1,250m (south-west)	Tributary of Padbury Brook			Spray irrigation

3.2.5 According to Environment Agency records, there are 24 current consented surface water discharges within 1km of the route in the study area as summarised in Table 3 (see Maps WR-01-018 and WR-01-019 in Volume 5, Water Resources and Flood Risk Assessment Map Book for locations).

Table 3: Surface water discharge consents

Reference number	Permit identifier	Distance (and direction) from route (m)	Discharge type	Receiving water body
CFA13WD76	AW1NF184	65m (north-east)	Sewage discharge - final/treated effluent	Tributary of the Padbury Brook
CFA13WD5	AW1NF514	295m (south-west)	Sewage discharge - storm overflow/storm tank	Adjoining watercourse
CFA13WD79	EPRLP3823GJ	145m (south-west)	Sewage discharge - final/treated effluent	Tributary of the Padbury Brook
CFA13WD77	NPSWQD009917	610m (south-west)	Sewage discharge - final/treated effluent	Ditch to Mill Stream
CFA13WD78	PR1NF1675	245m (north-east)	Sewage discharge - final/treated effluent	Tributary of the Padbury Brook
CFA13WD9	PR1NF1676	25m (north-east)	Sewage discharge - final/treated effluent	Tributary of the Padbury Brook
CFA13WD10	PR1NF1677	385m (north-east)	Sewage discharge - final/treated effluent	Tributary of the Padbury Brook

⁷ Surface water abstractions for public water supply are not included.

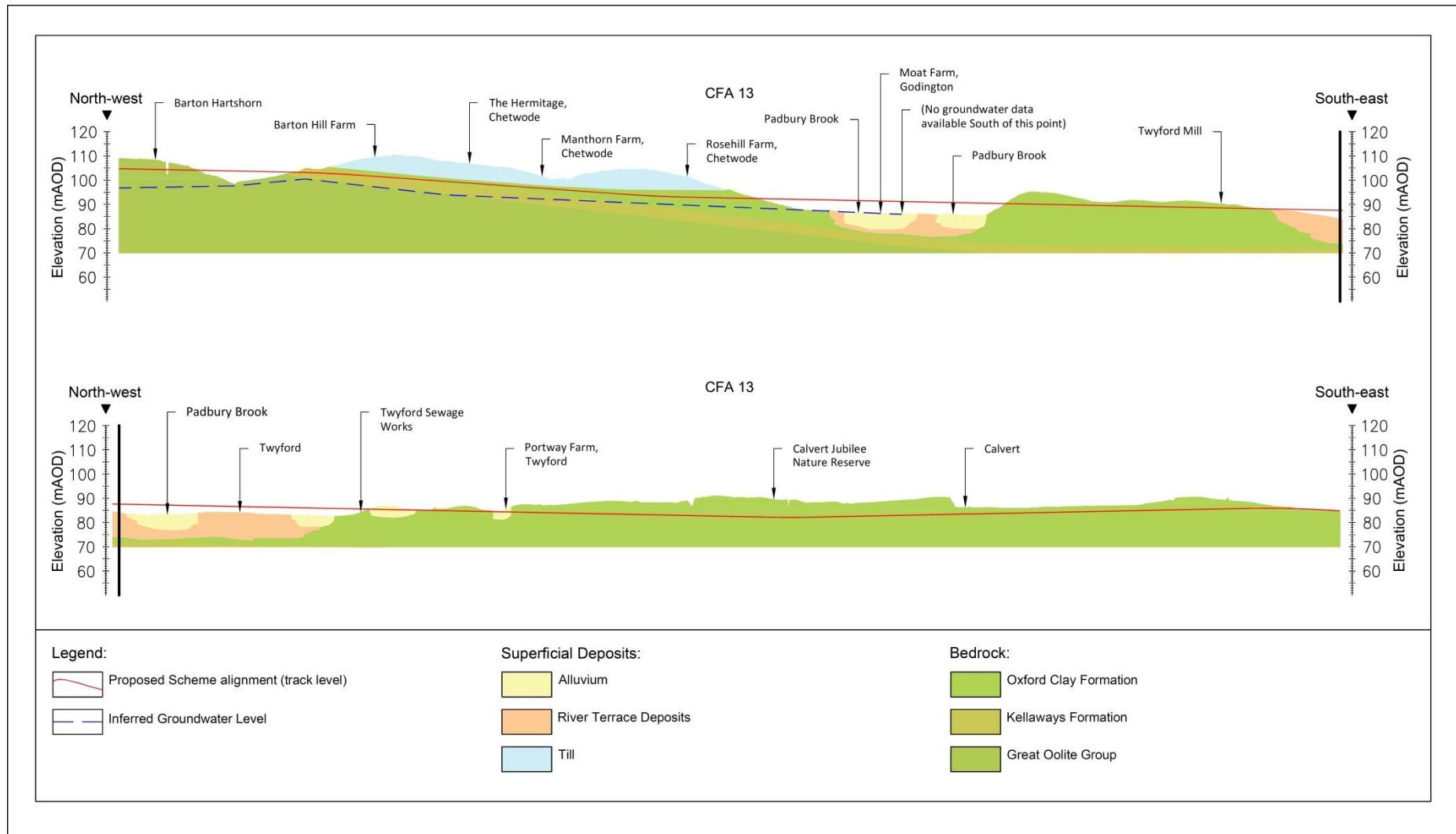
Reference number	Permit identifier	Distance (and direction) from route (m)	Discharge type	Receiving water body
CFA13WD8	PR1NF1678	5m (north-east)	Sewage discharge - final/treated effluent	Tributary of the Padbury Brook
CFA13WD12	PR1NF1679	375m (north-east)	Sewage discharge - final/treated effluent	Tributary of the Padbury Brook
CFA13WD11	PR1NF1680	315m (north-east)	Sewage discharge - final/treated effluent	Tributary of the Padbury Brook
CFA13WD13	PR1NF1787	120m (north-east)	Sewage discharge - final/treated effluent	Tributary of the Padbury Brook
CFA13WD33	PRCLF14247	759m (north-east)	Sewage discharge - final/treated effluent	Tributary of River Tove
CFA13WD20	PRCNF05213	880m (north-east)	Sewage discharge - final/treated effluent	Tributary of the Padbury Brook
CFA13WD61	PRCNF05581	739m (north-east)	Sewage discharge - final/treated effluent	Tributary of the Padbury Brook
CFA13WD7	PRCNF05984	497m (south-west)	Sewage discharge - final/treated effluent	Padbury Brook
CFA13WD60	PRCNF14444	529m (south-west)	Sewage discharge - final/treated effluent	Padbury Brook
CFA13WD63	PRCNF17003	931m (south-west)	Sewage discharge - final/treated effluent	Tributary of the Padbury Brook
CFA13WD69	PRCNF17853	181m (north-east)	Sewage discharge - final/treated effluent	Tributary of the Padbury Brook
CFA13WD70	PRCNF18185	220m (north-east)	Sewage discharge - final/treated effluent	Tributary of the Padbury Brook
CFA13WD1	PRCNF01228	375m (north-east)	Sewage discharge - final/treated effluent	Padbury Brook
CFA13WD21	PRCNF05581	735m (north-east)	Sewage discharge - final/treated effluent	Tributary of the Padbury Brook

3.3 Groundwater

3.3.1 A summary of the geological units present in CFA13, along with their hydrogeological characteristics, is presented in the Land Quality section in Volume 2, CFA Report 13, Section 8.

3.3.2 Map WR-02-013 (Volume 5, Water Resources and Flood Risk Assessment Map Book) indicates the spatial distribution of the uppermost superficial and bedrock formations within CFA13. A schematic cross-section along the line of the route in the study area with regard to geological strata, groundwater elevations (where known) and the Proposed Scheme is presented in Figure 1.

Figure 1: Schematic geological cross-section for the study area



3.3.3 According to Environment Agency and Cherwell and Aylesbury Vale District Council records, there are no known licensed or unlicensed groundwater abstractions or source protection zones (SPZ) within 1km of the route. There is the potential for further unlicensed abstractions to exist, as a licence is not required for abstraction volumes below 20m³ per day.

3.3.4 Table 4 summarises groundwater discharge consents to groundwater directly or via land, within 1km of the route.

Table 4: Discharge consents to groundwater

Reference number	Permit identifier	Distance (and direction) from route (m)	Discharge type	Receiving waterbody
CFA13WD66	Prclf17531	300m (north-east)	Sewage discharges - final/treated effluent - not water company	Oxford Clay Formation via soakaway
CFA13WD72	Npswqd003673	200m (north-east)	Sewage discharges - final/treated effluent - not water company	Till via soakaway

3.4 Surface water/groundwater interaction

3.4.1 Table 5 summarises the surface water/groundwater interactions within 1km of the route. Map references are given for Map WR-02-013 (Volume 5, Water Resources and Flood Risk Assessment Map Book).

Table 5: Surface water/groundwater interaction

Location description (and map reference)	Distance (m) and direction from route	Formation	Elevation (metres above Ordnance Datum, m AOD)	Comments
Spring approximately 200m south-west of Rosehill Farm, Chetwode (Map WR-02-013, D6)	180m (north-east)	Glaciofluvial Deposits	96m AOD	Contributes to flows to a surface water abstraction 150m to the south
Issues approximately 300m south-west of Garden Cottages, Barton Hartshorn (Map WR-02-013, C6)	350m (north-east)	Glaciofluvial Deposits and/or Kellaways Formation	106m AOD	Feeds a tributary of the Padbury Brook
Springs approximately 350m north of Manor Farm, Barton Hartshorn (Map WR-02-013, C6)	800m (north-east)	Glaciofluvial Deposits and/or Kellaways Formation	110m AOD	Feeds a tributary of the Padbury Brook

3.5 Water dependent habitats

3.5.1 Table 6 summarises the water dependent habitats within 1km of the route. The table identifies where a water dependency exists. The assessment of residual impact or mitigation measures on water dependent ecology receptors is found in the Ecology section in Volume 2, CFA Report 13, Section 7. Map references are given for the Volume 5, Ecology Map Book.

Table 6: Description of water dependent habitats

Name/location	Distance	Designation	Comments
Calvert Jubilee LWS is located north-west of Calvert and immediately to the east of Grebe Lake. (Map EC-01-029, G7)	Partially within the extent of the consolidated construction boundary of the Proposed Scheme.	LWS	Designated for grassland, scrub, woodland and wetland habitats as well as for its assemblage of wintering birds.
Calvert Brick Pits LWS is located adjacent to the Calvert Jubilee LWS, north-east of Charlton. (Map EC-01-029, F7)	The northern edge of the site is partially within the extent of the consolidated construction boundary of the Proposed Scheme.	LWS	Incorporates Grebe Lake.
Barton Hartshorn Railway Wood LWS is to approximately 500m to the north-west of School End, approximately 500m south-west of Barton Hartshorn. (Map EC-01-031, D6)	Partially within the extent of the consolidated construction boundary of the Proposed Scheme.	LWS	Designated for its remnant fen, wet woodland and wet grassland habitats.
Calvert Railway Station LWS is to the south of School Hill, immediately to the north-east of Calvert. (Map EC-01-029, I6)	Within the extent of the consolidated construction boundary of the Proposed Scheme.	LWS	The site was designated for its wet grassland and scattered scrub, notable plants, invertebrates, amphibians and reptiles. These are no longer present, however, due to recent vegetation clearance.
Decoypond Wood LWS is located to the south-east of Calvert village. (Map EC-01-028, C6)	Partially within the extent of the consolidated construction boundary of the Proposed Scheme.	LWS	Designated for ancient semi-natural woodland. Contains an old decoy pond.
Field A Cowley Farm LWS, approximately 100m south-west of Cowley Farm. (Map EC-01-030, F4)	400m from the Proposed Scheme.	LWS	Damp unimproved grassland.
Chetwode cutting is located between Rosehill Cottages and Chetwode Grange to the south-west of Chetwode. (Map EC-01-031, H7)	Partially within the extent of the consolidated construction boundary of the Proposed Scheme.	Biological notification site (BNS)	A section of disused railway line, of interest for neutral grassland and ponds.
Field B Cowley Farm BNS, approximately 300m south-west of Cowley Farm. (Map EC-01-030, F5)	200m from the Proposed Scheme.	BNS	The southern corner of this field contains a pocket of damp grassland.

4 Site specific surface water assessment

4.1 Summary of assessment

- 4.1.1 Table 7 summarises the potential impacts and effects to surface water features from the Proposed Scheme in the study area. Only those impacts and effects that are classed as significant are presented in Volume 2, CFA Report 13, Section 13.4.
- 4.1.2 Table 7 only includes water features which could potentially be affected by the Proposed Scheme. Features such as isolated ponds and drains which will lie outside the construction footprint and area of impact of the Proposed Scheme are not included. Details of these features are, however, provided in Table 1. Map references refer to those presented on Maps WR-01-018 and WR-01-019 (Volume 5, Water Resources and Flood Risk Assessment Map Book).
- 4.1.3 The draft CoCP referred to in Table 7 sets out the measures and standards of work that will be applied to the construction of the Proposed Scheme (see Volume 5: Appendix CT-003-000/1). These will provide effective management and control of the impacts during the construction period.

Table 7: Summary of potential impacts to surface water

Surface water feature/receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
Water features									
Watercourses and water bodies adjacent to landfill site, south of Calvert.	Low	Construction of cuttings past landfill site.	The route will avoid direct contact with the landfill site to the south of Calvert. Therefore, there will be no direct impact on the integrity of the landfill containment measures. During construction of the cuttings past the Calvert landfill site, there is a low risk that leachate could be detected.	Moderate impact Slight effect (Not significant)	Monitoring during construction (see Section 4.2 of this report for details).	Moderate impact Slight effect (Not significant)	Further assessment and pre-construction investigation and remedial works if required (see Section 4.2 of this report for details).	Minor impact Neutral effect (Not significant)	Construction (temporary)
Field drain network to the east of Calvert including tributaries to the drain identified by the IDB as M23 (SWC-CFA13-12).	Moderate	Access road at Calvert cutting and general construction works.	Approximately four field drains and one pond may be lost or potentially affected by general construction works to the east of Calvert. No impact in terms of water resources.	Moderate impact Moderate effect (Significant)	Replacement of lost pond area and creation of new surface water drainage channels	Negligible impact Neutral effect (Not significant)	None	Negligible impact Neutral effect (Not significant)	Construction (permanent)
Tributary to the drain identified by the IDB as M23 (SWC-CFA13-01, SWC-CFA13-13 and SWC-CFA13-14).	Moderate	Shepherds Furze inverted siphon at Calvert cutting (SWC-CFA13-01). Access road at Calvert cutting (SWC-CFA13-13). Aylesbury Link railway line realignment	During works for the culverting of the watercourse, there is a potential for temporary effects during construction, for example, a short-term increase in sediment loading and temporary impacts to flow.	Moderate impact Moderate effect (Significant)	Draft CoCP measures to control sediment mobilisation and risk of spills. Pre- and post-construction monitoring. Refer to Section 4.2 of this report for	Minor impact Slight effect (Not significant)	None	Minor impact Slight effect (Not significant)	Construction (temporary)

Surface water feature/receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
		(SWC-CFA13-14). Sustainable placement area Balancing pond and associated drainage	See Section 4.2 of this report for details.		further details.				
Tributary to the drain identified by the IDB as M23 (SWC-CFA13-01, SWC-CFA13-13 and SWC-CFA13-14).	Moderate	Balancing pond and associated drainage	Permanent impact on flow regime in receiving watercourse. Deterioration in water quality from routine discharges from the railway and associated infrastructure or spills.	Negligible impact Neutral effect (Not significant)	Balancing pond before outfall to watercourse to restrict runoff rates and limit effect on water quality.	Negligible impact Neutral effect (Not significant)	None	Negligible impact Neutral effect (Not significant)	Construction (permanent)
Two tributaries of Padbury Brook labelled by the IDB as M23 (SWC-CFA13-15) and M24 (SWC-CFA13-16).	Moderate	Culverts beneath the Calvert IMD and railhead Sustainable placement area Balancing pond and associated drainage	Construction of culverts greater than 100m in length is proposed at the Calvert IMD. Realignment of M23 around sustainable placement Potential sediment mobilisation or spills during construction.	Moderate impact Moderate effect (Significant)	The mitigation measures set out within the draft CoCP to control sediment mobilisation and risk of spills. Pre- and post-construction monitoring. Opportunity for restoration on M23 when railhead decommissioned. See Section 4.2 of this report for further details.	Negligible impact Neutral effect (Not significant)	None	Negligible impact Neutral effect (Not significant)	Construction (temporary)

Surface water feature/receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
Two tributaries of Padbury Brook labelled by the IDB as M23 (SWC-CFA13-15) and M24 (SWC-CFA13-16).	Moderate	Balancing pond and associated drainage	Permanent impact on flow regime in receiving watercourse. Deterioration in water quality from routine discharges from the railway and associated infrastructure or spills.	Negligible impact Neutral effect (Not significant)	Balancing pond before outfall to watercourse to restrict runoff rates and limit effect on water quality.	Negligible impact Neutral effect (Not significant)	None	Negligible impact Neutral effect (Not significant)	Construction (permanent)
Watercourse S75 (tributary of Padbury Brook) (SWC-CFA13-02, SWC-CFA13-17 and SWC-CFA13-20).	Moderate	Calvert cutting, Perry Hill overbridge, access roads and associated earthworks. An existing railway culvert will be extended (SWC-CFA13-17) and the watercourse diverted at Calvert cutting and Perry Hill overbridge. The watercourse will be encompassed within the new drainage network. Six balancing ponds and associated drainage	During diversion works for the channel and culverting and the balancing ponds and drainage, there is potential for temporary effects related to construction, for example, a short-term increase in sediment loading and temporary impacts to flow. Potential sediment mobilisation or spills during construction. Refer to Section 4.2 of this report for further details.	Moderate impact Moderate effect (Significant)	Draft CoCP measures to control sediment mobilisation and risk of spills. Pre- and post-construction monitoring. Refer to Section 4.2 of this report for further details.	Minor impact Slight effect (Not significant)	None	Minor impact Slight effect (Not significant)	Construction (temporary)

Surface water feature/receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
Watercourse S75 (tributary of Padbury Brook) (SWC-CFA13-02, SWC-CFA13-17 and SWC-CFA13-20).	Moderate	Six balancing ponds and associated drainage	Permanent impact on flow regime in receiving watercourse. Deterioration in water quality from routine discharges from the railway and associated infrastructure or spills.	Negligible impact Neutral effect (Not significant)	Balancing pond before outfall to watercourse to restrict runoff rates and limit effect on water quality.	Negligible impact Neutral effect (Not significant)	None	Negligible impact Neutral effect (Not significant)	Construction (permanent)
Drain S76 and pond (SWC-CFA13-03 and SWC-CFA13-21).	Moderate (drain) Low (pond)	Loss of pond and culvert and diversion drain at Portway embankment. Balancing pond and associated drainage	Diversion required at SWC-CFA13-03. Potential sediment mobilisation during construction.	Moderate impact Moderate effect (Significant)	See Section 4.2 of this report for further details. Draft CoCP measures to control sediment mobilisation and risk of spills.	Negligible impact Neutral effect (Not significant)	None	Negligible impact Neutral effect (Not significant)	Construction (temporary)
Drain S76 and pond (SWC-CFA13-03 and SWC-CFA13-21).	Moderate	Balancing pond and associated drainage	Permanent impact on flow regime in receiving watercourse. Deterioration in water quality from routine discharges from the railway and associated infrastructure or spills.	Negligible impact Neutral effect (Not significant)	Balancing pond before outfall to watercourse to restrict runoff rates and limit effect on water quality.	Negligible impact Neutral effect (Not significant)	None	Negligible impact Neutral effect (Not significant)	Construction (permanent)
Padbury Brook and unnamed tributaries. (SWC-CFA13-04, SWC-CFA13-05 and SWC-CFA13-06).	High (SWC-CFA13-04) Moderate (SWC-CFA13-05 and SWC-	Construction of Twyford viaduct (SWC-CFA13-04) and diversion works on two tributaries to new alignment through the viaduct (SWC-	Diversion required for tributary SWC-CFA13-05 See Section 4.2 of this report for further details.	Minor impact Moderate effect (Significant)	See Section 4.2 of this report for further details. Draft CoCP measures to control sediment mobilisation and risk of spills.	Negligible impact Neutral effect (Not significant)	None	Negligible impact Neutral effect (Not significant)	Construction (temporary)

Surface water feature/receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
	CFA13-06)	CFA13-05) and around associated balancing pond (SWC-CFA13-06). Two balancing ponds and associated drainage							
Padbury Brook and unnamed tributaries (SWC-CFA13-04, SWC-CFA13-05 and SWC-CFA13-06).	Moderate	Two balancing ponds and associated drainage	Permanent impact on flow regime in receiving watercourse. Deterioration in water quality from routine discharges from the railway and associated infrastructure or spills.	Negligible impact Neutral effect (Not significant)	Balancing pond before outfall to watercourse to restrict runoff rates and limit effect on water quality.	Negligible impact Neutral effect (Not significant)	None	Negligible impact Neutral effect (Not significant)	Construction (permanent)
Unnamed drain (tributary of Padbury Brook) (SWC-CFA13-07).	Moderate	Twyford cutting - culvert and diversion works.	The drain passes in culvert under the existing railway downstream of the new culvert. During diversion works for the channel and culverting and drainage, there is potential for temporary effects related to construction, for example, a short-term increase in sediment loading and temporary impacts to flow. Potential sediment mobilisation or spills during construction.	Negligible impact Neutral effect (Not significant)	Refer to Section 4.2 of this report for further details. Draft CoCP measures to control sediment mobilisation and risk of spills.	Negligible impact Neutral effect (Not significant)	None	None	Not applicable

Surface water feature/receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
Padbury Brook near Godington (SWC-CFA13-08 and SWC-CFA13-09).	High	Godington east viaduct construction and diversion and construction works at Godington west viaduct.	Foundations for pier will encroach on channel of watercourse at SWC-CFA13-09 (Godington west viaduct) – realignment over 35m and potential impacts on water quality during construction works.	Minor impact Moderate effect (Significant)	Realigned channel to be constructed in advance of works. See Section 4.2 of this report for further details.	Negligible impact Neutral effect (Not significant)	None	Negligible impact Neutral effect (Not significant)	Construction (temporary)
Unnamed drain (tributary of Padbury Brook) (SWC-CFA13-10).	Moderate	Chetwode embankment culvert and diversion works. Balancing pond and associated drainage	The drain will be diverted and culverted (SWC-CFA13-10). Potential for sediment mobilisation during construction.	Minor impact Slight effect (Not significant)	See Section 4.2 for further details. Draft CoCP measures to control sediment mobilisation and risk of spills.	Negligible impact Neutral effect (Not significant)	None	Negligible impact Neutral effect (Not significant)	Construction (temporary)
Unnamed drain (tributary of Padbury Brook) (SWC-CFA13-10).	Moderate	Balancing pond and associated drainage	Permanent impact on flow regime in receiving watercourse. Deterioration in water quality from routine discharges from the railway and associated infrastructure or spills.	Negligible impact Neutral effect (Not significant)	Balancing pond before outfall to watercourse to restrict runoff rates and limit effect on water quality.	Negligible impact Neutral effect (Not significant)	None	Negligible impact Neutral effect (Not significant)	Construction (permanent)
Unnamed drain (tributary of Padbury Brook) (SWC-CFA13-11 and SWC-CFA13-22).	Moderate	Barton Hartshorn embankment, culvert/diversion works, two balancing ponds with drainage.	The drain will be diverted and culverted (SWC-CFA13-11) and culverted under access road at SWC-CFA13-21. Potential sediment mobilisation during works.	Minor impact Slight effect (Not significant)	See Section 4.2 for further details. Draft CoCP measures to control sediment and risk of spills.	Negligible impact Neutral effect (Not significant)	None	Negligible impact Neutral effect (Not significant)	Construction (temporary)

Surface water feature/receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
Unnamed drain (tributary of Padbury Brook) (SWC-CFA13-11 and SWC-CFA13-22).	Moderate	Two balancing ponds and associated drainage	Permanent impact on flow regime in receiving watercourse. Deterioration in water quality from routine discharges from the railway and associated infrastructure or spills.	Negligible impact Neutral effect (Not significant)	Balancing pond before outfall to watercourse to restrict runoff rates and limit effect on water quality.	Negligible impact Neutral effect (Not significant)	None	Negligible impact Neutral effect (Not significant)	Construction (permanent)
Abstractions/discharge consents									
Spray irrigation abstractions SWB3/SWB4	Moderate	General construction works.	The abstractions are on tributaries of the Padbury Brook upstream of the location where it is crossed by the route and thus unaffected by construction work.	Negligible impact Neutral effect (Not significant)	None required	Negligible impact Neutral effect (Not significant)	None	None	Not applicable

4.2 Detailed assessments

Assessment of potential impact of Calvert Landfill

4.2.1 For over 4km in this area the route would be constructed in retained cutting in close proximity to the Calvert landfill site. The landfill is currently operated by FCC Environment Ltd. The Calvert cutting in the area will be up to 8.1m below existing ground level.

4.2.2 The Land Quality assessment of potential impacts from construction in contaminated areas is set out in Volume 2, CFA Report 13, Section 8. This includes accounting for the draft CoCP requirements (Section 11) that will provide effective management and control during construction, starting with pre-construction ground investigation and subsequent risk assessment. The initial screening assessment for the Proposed Scheme has identified a potential risk that leachate could be detected during construction of the cutting adjacent to the Calvert Landfill pits no. 4 & 5 (active) and Calvert Landfill pit no. 1 (closed). The risk assessment, however, concluded that the temporary effect will be neutral in both cases (see Volume 5: Appendix LQ-001-013, Section 3, for the detailed risk assessment). This will be confirmed following the pre-construction ground investigation and the subsequent risk assessment and will identify if other mitigation is required for water resources.

4.2.3 Should the pre-construction ground investigation and risk assessment confirm a potential risk of leachate release a site-specific monitoring programme will be put in place in consultation with the Environment Agency and the IDB. Any monitoring could include monitoring of the quality of water captured by the drainage system for the Proposed Scheme once in place as well as local surface watercourses and water bodies to determine if there is any deterioration in water quality.

4.2.4 If the site-specific monitoring indicates a significant risk to water resources, this will inform the detailed design which will need to provide a means of separating potentially contaminated drainage from other track drainage, such as the use of cut-off valves and the collection and appropriate disposal of drainage water to ensure that the polluted water will not enter receiving watercourses.

Assessment of potential impacts of proposed crossings of surface water features

4.2.5 The locations and descriptions of the crossings over surface water features in the area that are required for the Proposed Scheme are given in Table 8. There are a number of watercourses where the large footprint of the consolidated construction boundary, which includes the Calvert IMD and temporary railhead and the sustainable placement area, will result in substantial lengths of the watercourse being affected. The effects on ecology receptors are addressed in the Ecology section, Volume 2, CFA Report 13, Section 7. Map references in the table refer to those presented on Maps WR-01-018 and WR-01-019 (Volume 5, Water Resources and Flood Risk Assessment Map Book).

Table 8: Summary of watercourse crossings

Water feature	Crossing	Description	Length* (m)	WFD water body, designation and current status
Tributary of M23 drain draining from Calvert Jubilee LWS lake	SWC-CFA13-01	Shepherds Furze inverted siphon at Calvert cutting.	105m	No status class shown in RBMP – assumed status Good
Watercourse S75 (tributary of Padbury Brook)	SWC-CFA13-02	Diversion at Calvert cutting	68om	No status class shown in RBMP – assumed status Moderate
Field drain identified by the IDB as drain S76	SWC-CFA13-03	Diversion and culvert at Portway embankment	210m	No status class shown in RBMP – assumed status Moderate
Padbury Brook	SWC-CFA13-04	Twyford viaduct	40m	Padbury Brook (The Twin) (GB105033038210) Moderate
Tributary of Padbury Brook	SWC-CFA13-05	Diversion at Cowley embankment/Twyford viaduct	100m	No status class shown in RBMP – assumed status Moderate
Tributary of Padbury Brook	SWC-CFA13-06	Diversion at Twyford viaduct	260m	No status class shown in RBMP – assumed status Moderate
Unnamed watercourse	SWC-CFA13-07	Culvert and diversion at Twyford cutting	60m	No status class shown in RBMP – assumed status Moderate
Padbury Brook	SWC-CFA13-08	Godington east viaduct	20m	Padbury Brook (The Twin) (GB105033038210) Moderate
Padbury Brook	SWC-CFA13-09	Culvert and diversion at Godington west viaduct	40m	Padbury Brook (The Twin) (GB105033038210) Moderate
Drain	SWC-CFA13-10	Culvert and diversion at Chetwode embankment.	100m	No status class shown in RBMP – assumed status Moderate
Unnamed watercourse	SWC-CFA13-11	Culvert and diversion at Barton Hartshorn embankment	60m	No status class shown in RBMP – assumed status Moderate
Tributary to the drain identified by the IDB as M23	SWC-CFA13-12	Calvert cutting.	20m	No status class shown in RBMP – assumed status Good

Water feature	Crossing	Description	Length* (m)	WFD water body, designation and current status
Pond draining from Calvert Jubilee LWS lake.	SWC-CFA13-13	Calvert cutting access road.	Entire pond.	Not applicable.
Tributary of M23 drain draining from Calvert Jubilee LWS lake	SWC-CFA13-14	Aylesbury Link railway realignment culvert Sustainable placement - about 500m of drain buried and 650m diversion provided.	40m	No status class shown in RBMP – assumed status Good
Drain identified by the IDB as M23	SWC-CFA13-15	Culverts at Calvert IMD and railhead. Sustainable placement - about 850m of drain buried and 850m diversion provided.	Overall 500m during construction phase	No status class shown in RBMP – assumed status Good
Drain identified by the IDB as M24	SWC-CFA13-16	Culvert at Calvert IMD and railhead. Culvert is extended beneath permanent infrastructure mitigation earthworks.	230m	No status class shown in RBMP – assumed status Good
Watercourse S75 (tributary of Padbury Brook)	SWC-CFA13-17	Extended culvert at existing railway crossing.	20m	No status class shown in RBMP – assumed status Moderate
Pond south-east of Twyford Sewage Treatment Works	SWC-CFA13-19	Calvert cutting	Entire pond	Not applicable
Watercourse S75 (tributary of Padbury Brook)	SWC-CFA13-20	Culvert under Perry Hill road diversion	115m	No status class shown in RBMP – assumed status Moderate
Pond north of Twyford Sewage Treatment Works	SWC-CFA13-21	Portway embankment	Entire pond	Not applicable
Unnamed watercourse	SWC-CFA13-22	Culvert at Barton Hartshorn embankment access road.	10m	No status class shown in RBMP – assumed status Moderate

* The length is based on the consolidated construction boundary. The actual length of any culverts is to be confirmed.

4.2.6 Shepherds Furze inverted siphon (see Map WR-01-018 SWC-CFA13-01), the crossings under Calvert IMD (see Map WR-01-018 SWC-CFA13-15 and SWC-CFA13-16) and the three viaducts (see Map WR-01-018 and Map WR-01-019; SWC-CFA13-04, SWC-CFA13-05, SWC-CFA13-06, SWC-CFA13-08 and SWC-CFA13-09) are addressed separately because of their particular features. This section addresses the impacts for all other crossings.

4.2.7 Design mitigation will be used to address the potential impacts of culvert crossings. The Environment Agency will be consulted on the design of the culverts and diversion proposals and any other mitigation measures. Mitigation measures could include:

- avoiding culverts where possible and maintaining an open watercourse;
- minimising the culvert lengths as far as possible, even if this requires some realignment of the upstream approach reach;
- maintaining the natural bed profile within the channel, both in terms of channel gradients and substrates;
- maintaining natural flow depths, widths and velocities, (including natural variance and diversity) at the culvert inlet and outlet;
- constructing realigned channel sections in advance to allow stabilisation and vegetation growth to minimise sediment mobilisation when the flow is first diverted; and
- other measures, to be agreed with the Environment Agency, to ensure that the culverts are environmentally sympathetic to minimise their impacts on natural processes and biodiversity as far as possible.

4.2.8 Construction of crossings will follow best practice as set out in the draft CoCP.

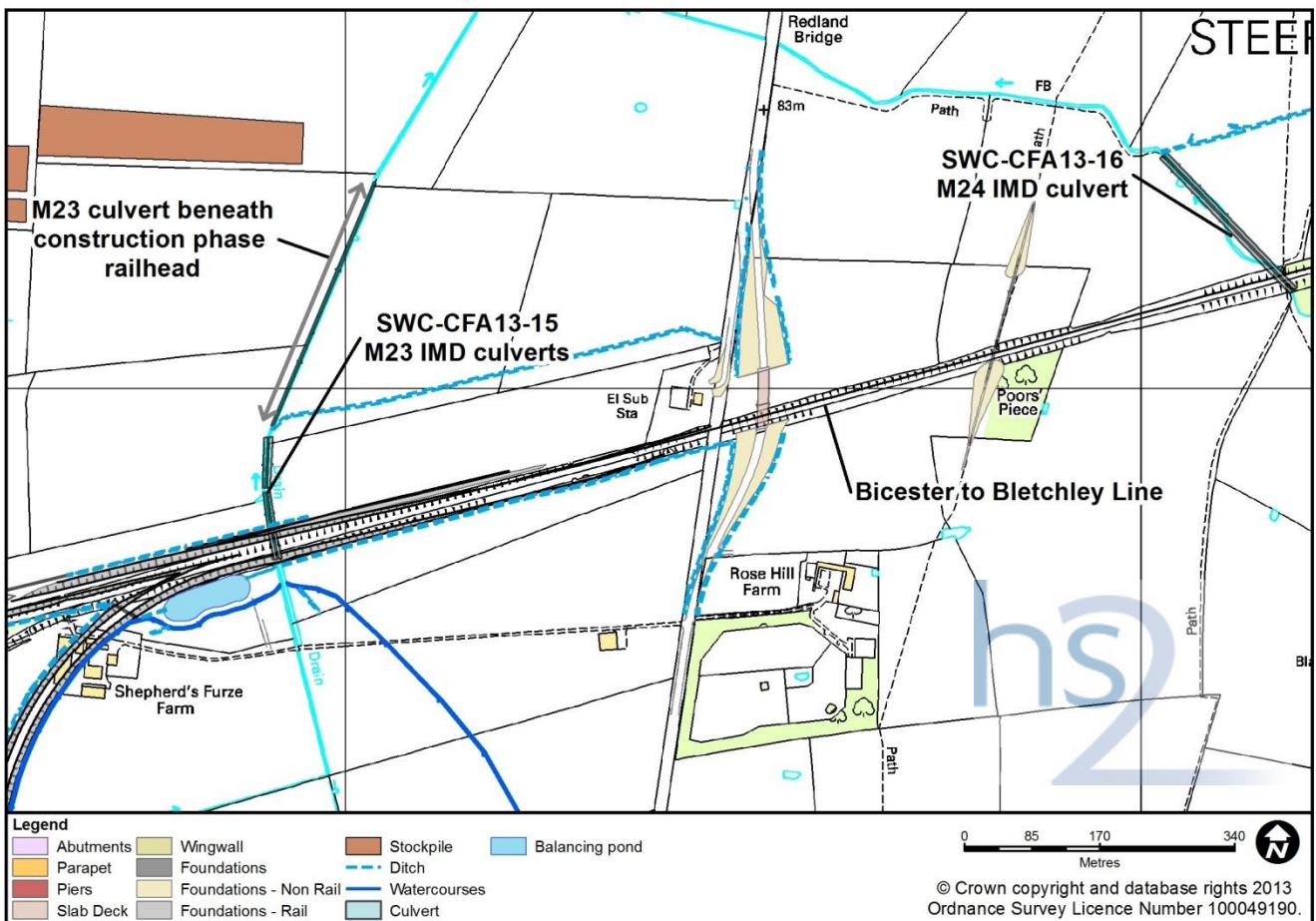
4.2.9 Although the scale of impact may vary at each crossing these measures will ensure that the impacts on these features are not significant.

Assessment of potential impacts of the Calvert IMD and construction phase railhead

4.2.10 The footprint of the proposed Calvert IMD and construction phase railhead is shown in Maps CT-05-055, CT-05-055-R1 and R2 and Maps CT-06-055, CT-06-055-R1 and R2 (Volume 2, CFA Report 13 Map Book). The depot and railhead are aligned east-west beside the existing Bicester to Bletchley Line with chords linking to the south-north route of the Proposed Scheme.

4.2.11 The IMD will cross two ordinary watercourses at this location, referred to by the Bedford Group IDB as M23 (see Map WR-01-018 SWC-CFA13-15) and M24 (see Map WR-01-018 SWC-CFA13-16) and shown in Figure 2. Neither of these water courses has been identified as a WFD water body by the Environment Agency. They converge south of Steeple Claydon as a watercourse referred to by the Environment Agency as the 'Twin' before joining the Padbury Brook; these water bodies have a WFD status of Good and Moderate respectively.

Figure 2: Water crossings at the Calvert IMD and railhead



4.2.12 There are existing culverts, approximately 30m long twin pipe, at both crossings under the Bicester to Bletchley Line which will be replaced and extended. Both new permanent crossings will be twin pipes of 1.2m diameter as at present. The length of the western-most crossing culvert (SWC-CFA13-15) will be increased to 150m to allow for the increased width of the Proposed Scheme in the permanent condition. This will be in three separate culvert sections with two 5m long gaps to provide light for ecological benefit. The culvert at M24 (SWC-CFA13-16) will be increased to 230m. The greater length at this crossing is because it will pass beneath infrastructure mitigation earthworks screening the IMD.

4.2.13 The Calvert IMD will have a larger footprint in the construction phase (due to the railhead) than its final size for the operations phase. During the construction phase this will necessitate culverting the M23 watercourse for an additional length of approximately 330m (i.e. in addition to a new permanent culvert beneath the smaller footprint of the permanent IMD). Following the construction phase there would be the opportunity to restore this section of the watercourse to its original form by removing the culvert extension.

4.2.14 At the detailed design stage mitigation will be used to address the potential impacts of these crossings, as for culverts in general. Given the scale of the culverts it is considered that the potential magnitude of the impact during construction could be moderate as there could be a temporary decrease in water quality. The effect would be moderate and further mitigation will be required. Prior to construction starting a site specific risk

assessment will be carried out as required by the draft CoCP and construction phasing and other similar measures identified to avoid unacceptable impacts on water quality. Monitoring will be required to confirm that the draft CoCP measures are adequate and to identify if further measures are required to control the temporary impact of sediment mobilisation.

4.2.15 The construction temporary effects will therefore be neutral and no further mitigation is required.

Potential impact of sustainable placement area at Shepherd's Furze Farm

4.2.16 The Proposed Scheme includes a large area of sustainable placement of excavated material between the route and the IMD in the vicinity of Sherherd's Furze Farm (see Map CT-06-055 (Volume 2, CFA Report 13 Map Book)).

4.2.17 The tributaries of M23 that cross this area will be realigned around the boundary of the sustainable placement area. Approximately 1.4km of existing drains will be realigned. A total length of about 1.5km of new channel will be provided. The existing drains are laid out in a geometric arrangement - the new channels will have a more natural profile and the design will seek to enhance ecological and hydromorphological conditions whilst providing adequate capacity for conveyance of storm run-off. The Bedford Group of Internal Drainage Boards will be consulted during the detailed design of the new watercourses.

4.2.18 The permanent channel realignments will be constructed in advance of other activities associated with the construction of the Proposed Scheme.

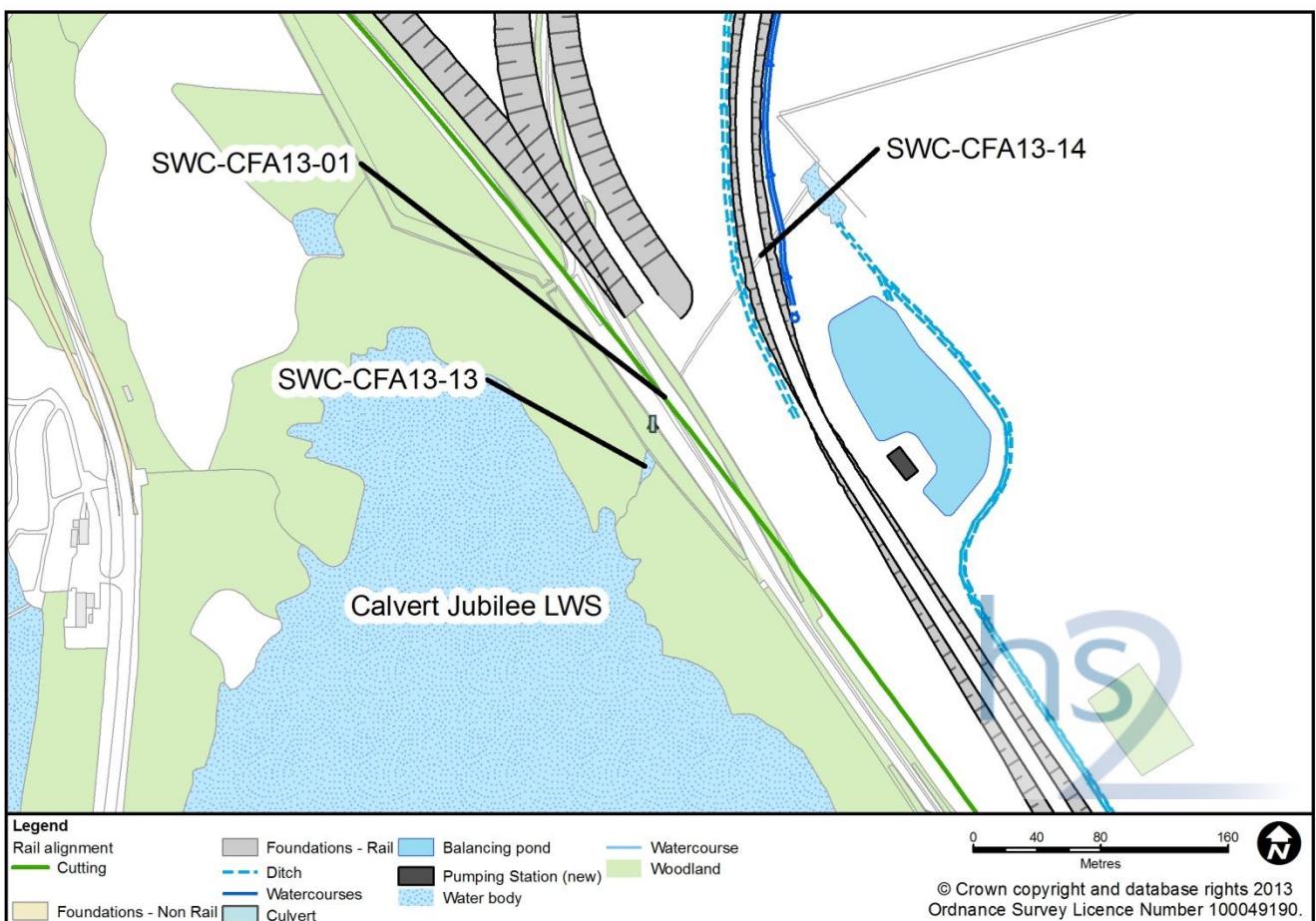
4.2.19 The area identified for sustainable placement is underlain by the Oxford Clay Formation which is unproductive strata. Suitable water quality criteria will be defined prior to material being placed to ensure that the existing water quality of surface watercourses or groundwater in the superficial deposits is not adversely affected by the quality of the placement material. The draft CoCP (Sections 11, 15 and 16) defines appropriate measures that will be followed to ensure any impacts to surface water quality are minimised.

Potential impacts of Proposed Scheme near Calvert Jubilee LWS

4.2.20 The route crosses a small watercourse (see Map WR-01-018 SWC-CFA13-01) draining from the lake within the Calvert Jubilee LWS and flowing eastwards towards the M23 IDB drain. This watercourse passes through a 52m culvert under the existing railway. The watercourse is crossed for a second time by the Aylesbury Link railway line realignment at SWC-CFA13-14 (see Figure 3). There is a pond located at the entrance to the existing culvert (which will also be crossed by a new access road SWC-CFA13-13, see Figure 3) suggesting that the capacity of the culvert may limit downstream flows to the north-east of the existing railway.

The drain leaves the existing culvert and flows to a small pond that discharges into a system of artificial drains which ultimately flow, via the M23 drain and The Twin, into Padbury Brook north of Steeple Claydon. These drains upstream of The Twin are not WFD classified water bodies.

Figure 3: Crossing SWC-CFA13-01, SWC-CFA13-13 and SWC-CFA13-14



- 4.2.21 There are no licenced abstractions on the drain or receiving waters between the existing culvert and Steeple Claydon. There is a consented discharge of sewage discharges from a single property at Werner Terrace. Although the discharge point is not given in the data made available by the Environment Agency, for the purpose of this assessment it is assumed to discharge to the Calvert Jubilee LWS.
- 4.2.22 The route will be in a retained cutting approximately 6m below ground at this location (refer to Section 5.2 for details of this cutting). An inverted siphon is therefore unavoidable being the only technically viable option. The inverted siphon is proposed to carry the existing drain under the Proposed Scheme main line, the IMD southern access chord and the realigned Aylesbury Link railway line. The proposed inverted siphon is will have two pipes 750mm in diameter and 105m long.
- 4.2.23 The siphon has been designed to have sufficient capacity to pass the 1 in 100 year flow with an allowance for climate change. The design capacity is the same as the existing culvert and therefore there will be no impact on water levels in the Calvert Jubilee LWS.
- 4.2.24 The siphon will be maintained to prevent blockage which could result in reduced hydraulic efficiency.
- 4.2.25 During construction the watercourse will need to be blocked temporarily and an over pumping system installed. The capacity of the pumped system will be equivalent to the

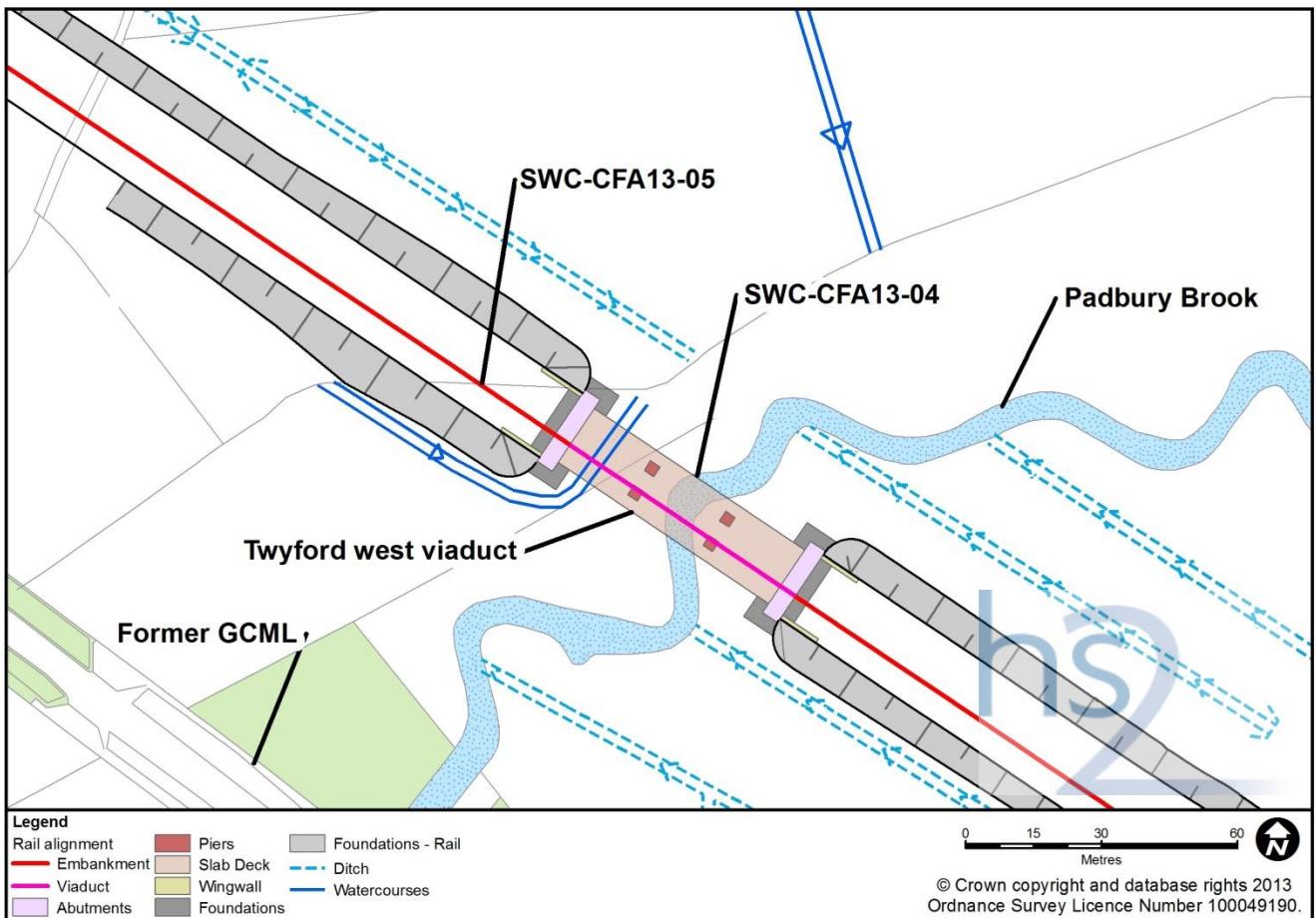
existing drain and draft CoCP measures will be applied to ensure that the risk of sediment mobilisation and contamination from spills are acceptable.

- 4.2.26 The magnitude of construction temporary impact will be minor as there will be no impact on the Calvert Jubilee LWS upstream or flows of the existing drain. The flow regime and sediment regime may be temporarily affected during the diversion of the existing culvert and the use of over-pumping to maintain the existing flow.
- 4.2.27 The value of the drain is considered to be moderate and therefore the significance of effect during construction is assessed as slight requiring no further mitigation.
- 4.2.28 The magnitude of the impact for the permanent situation is considered to be negligible and the effect neutral as the hydrology and sediment regimes of the drain downstream of the route crossing will not be affected.

Potential impacts of Twyford viaduct on the Padbury Brook and its tributaries

- 4.2.29 The route crosses the Padbury Brook, locally known as Mill Stream, by viaduct at Twyford (Map WR-01-018 SWC-CFA13-04 and Figure 4). The crossing location is within the WFD water body 'Padbury Brook (The Twin)' which is designated as a heavily modified water body currently at moderate ecological potential.
- 4.2.30 The Padbury Brook has an upstream catchment size of approximately 73.8km² at the crossing point which is 30% of the total catchment of Padbury Brook at its confluence with the Great Ouse. There is an existing upstream flow restriction within the catchment of the Padbury Brook throughout this CFA, caused by the embankments and underbridges of the former Great Central Main Line railway.
- 4.2.31 At the crossing there will be two piers which will be located outside of the main channel so no realignment will be required. The viaduct span will be approximately 50m.
- 4.2.32 As shown in Figure 4 two watercourses will pass beneath the proposed viaduct. At SWC-CFA13-05 (see map WR-01-018) the route crosses an existing drain, a moderate value receptor, which will be permanently diverted through the new Twyford viaduct. The drain will be diverted south-eastwards along the toe of the new embankment for the Proposed Scheme until it reaches the new viaduct. It will then be diverted through the viaduct to join the original drain alignment. The diversion is 86m long, 17m longer than the existing alignment.
- 4.2.33 The approximately 86m length of channel will be constructed in advance of the construction works and will be allowed to stabilise and vegetation establish to control the risk of sediment mobilisation when the drain is actually diverted into the new channel.
- 4.2.34 The magnitude of the impacts on flow and water quality in the Padbury Brook watercourse affected during construction is assessed as negligible and the impacts on the SWC-CFA13-05 (see map WR-01-018) drain as minor. Consequently the effect is assessed as neutral for SWC-CFA13-04 (see map WR-01-018) and slight for SWC-CFA13-05, neither is significant. No further mitigation is therefore required.

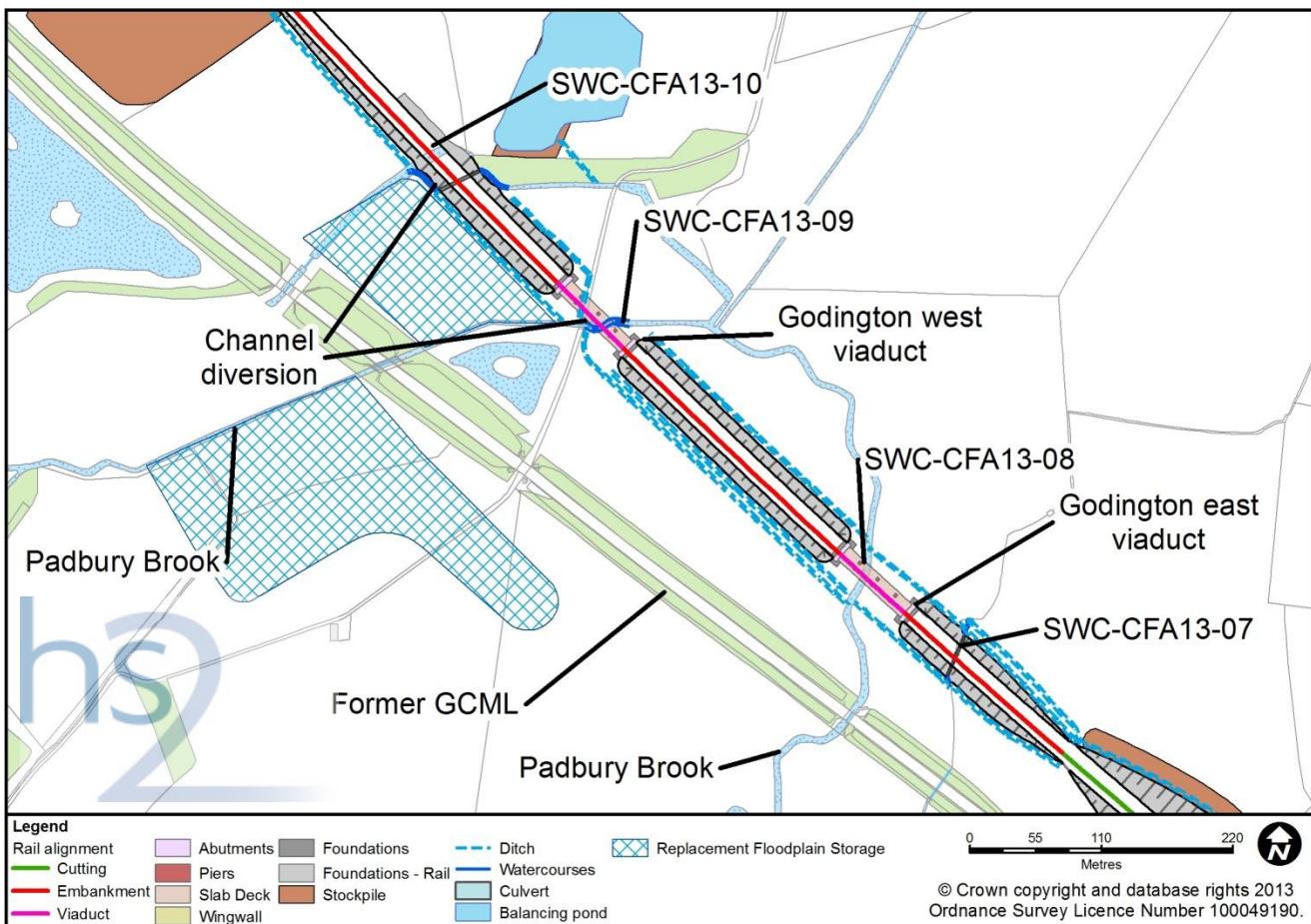
Figure 4: Channel arrangements at the Twyford viaduct – SWC-CFA13-04 and SWC-CFA13-05



Potential impacts of the Godington viaducts on the Padbury Brook and its tributaries

- 4.2.35 The route will cross the Padbury Brook and a tributary of the brook at SWC-CFA13-08 and SWC-CFA13-09 (see Map WR-01-019) near Godington (Figure 5). The Padbury Brook has an upstream catchment size of approximately 67.8km² at the downstream intersection with the Proposed Scheme.
- 4.2.36 There is an existing flow restriction caused by the embankments and underbridges of the former Great Central Main Line railway. The restriction is approximately 110m upstream of Godington west viaduct (SWC-CFA13-09) and 60m downstream of Godington east viaduct (SWC-CFA13-08) on the Padbury Brook.
- 4.2.37 Godington east viaduct at SWC-CFA13-08 (see Map WR-01-019) will not constrict flow and piers will be located outside of the main channel. The need to temporarily or permanently divert the Padbury Brook has therefore been avoided. Therefore there will be no temporary impacts during construction or permanent impacts as a result of construction and the significance of effects is assessed as neutral.

Figure 5: Proposed viaduct locations at Godington – SWC-CFA13-08, SWC-CFA13-09 and SWC-CFA13-10



4.2.38 Godington west viaduct at SWC-CFA13-09 will also span the main channel. In this case, however, a pier will be located within the main channel of the river and therefore it is proposed to use a short (40m) diversion to avoid any temporary or permanent impact on flow and sediment regimes during construction or as a result of construction.

4.2.39 The short diversion will be designed to ensure that the existing flow and sediment regimes are maintained and acceptable to the Environment Agency. Due to the very small scale of this diversion and the fact that the river is currently impacted some 60m upstream of the crossing by the former Great Central Main Line railway the magnitude of the impact for construction temporary and permanent is considered to be minor giving a significance of effects as slight.

5 Site specific groundwater assessment

5.1 Summary of assessment

5.1.1 The following table summarises the potential impacts to hydrogeology (groundwater), abstractions, water dependent habitats and surface water/groundwater interactions. Only those impacts and effects that are classed as significant are presented in Volume 2, CFA Report 13, Section 13.4.

Table 9: Summary of potential impacts to groundwater

Receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
Hydrogeology (groundwater)									
Oxford Clay Formation and deep aquifers	Low	Calvert cutting	The cutting will pass within the Oxford Clay Formation which is designated unproductive strata. As such, there is no potential impact on groundwater or deep aquifers due to the cutting.	Negligible impact Neutral effect (Not significant)	None	Negligible impact Neutral effect (Not significant)	None	None	Not applicable
Oxford Clay Formation and deep aquifers	Low	Sustainable placement area bound by School Hill, the Aylesbury Link railway line and the Bicester to Bletchley Line.	The area selected for placement of materials will overlie the Peterborough Member of the Oxford Clay Formation. There are no superficial deposits in this area. The Peterborough Member is an unproductive aquifer and as such, no groundwater will be affected by this sustainable placement area.	Negligible impact Neutral effect (Not significant)	None	Negligible impact Neutral effect (Not significant)	None	None	Not applicable

Receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
Alluvium and River Terrace Deposits Secondary A aquifers	Moderate	Portway, Twyford east, Twyford, Cowley, Godington, Chetwode embankments Twyford, Godington east and west viaducts	The Alluvium and River Terrace Deposits are present along the valley of the Padbury Brook and its tributaries, and may contain shallow groundwater. The superficial Deposits are likely to be in hydraulic connectivity with the watercourses. The foundations for the viaducts and culverts which cross the valleys will be constructed using good practice as described in the draft CoCP.	Negligible impact Neutral effect (Not significant)	None	Negligible impact Neutral effect (Not significant)	None	None	Not applicable
Glaciofluvial Deposits Secondary A aquifer	Moderate	Chetwode cutting	The cutting may intercept groundwater in Glaciofluvial Deposits present in the north of CFA13. There could be a localised impact, draining groundwater from the Secondary A aquifer into the cutting. A spring which issues from near the exposed Glaciofluvial Deposits could be disrupted by the cutting. The spring, however, is small and only likely to contribute a very small proportion of baseflow to the local watercourse. See Section 5.2 of this report for further discussion.	Minor impact Slight effect (Not significant)	None	Minor impact Slight effect (Not significant)	None	Minor impact Slight effect (Not significant)	Construction (permanent)

Receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
Kellaways Formation Secondary A aquifer	Moderate	Chetwode cutting	<p>There are no licensed abstractions within 1km of the route, and no evidence to suggest that springs fed by groundwater from the Kellaways Formation make a significant contribution to surface watercourses. Any drainage from the cutting will be discharged to local surface watercourses via detention ponds.</p> <p>See Section 5.2 of this report for further discussion</p>	Minor impact Slight effect (Not significant)	None	Minor impact Slight effect (Not significant)	None	Minor impact Slight effect (Not significant)	Construction (permanent)
Cornbrash Formation Secondary A aquifer	Moderate	Chetwode cutting Barton to Mixbury cutting	<p>The route will penetrate the Cornbrash Formation to a depth of only a few metres. As a result it is unlikely that there could be a significant impact on groundwater within this aquifer.</p> <p>See Section 5.2 of this report for further discussion.</p>	Negligible impact Neutral effect (Not significant)	None	Negligible impact Neutral effect (Not significant)	None	None	Not applicable

Receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
Spring south-west of Rosehill Farm, Chetwode	Moderate	Chetwode cutting	The spring contributes a very small proportion of the stream flow to the Padbury Brook. Any disturbance to the spring flow will not adversely impact the overall flow in the Brook. See Section 5.2 of this report for further discussion	Minor impact Slight effect (Not significant)	None	Minor impact Slight effect (Not significant)	None	Minor impact Slight effect (Not significant)	Construction (permanent)
Minor watercourses fed by springs and issues.	Moderate	Barton to Mixbury cutting	The Barton to Mixbury cutting is likely to intercept the Cornbrash Formation and Superficial Deposits, where present. If groundwater is encountered, some groundwater would be drawn into the cutting instead of discharging as baseflow to nearby minor watercourses. See Section 5.2 of this report for further discussion.	Minor impact Slight effect (Not significant)	Any intercepted groundwater from the cutting would gather in the track drainage, which would discharge into the minor watercourse fed by these issues. As some watercourses may lose some flow in the short term during construction, there would be a temporary minor impact with a slight effect which is not significant.	Negligible impact Neutral effect (Not significant)	None	Negligible impact Neutral effect (Not significant)	Construction (permanent)

Receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
Springs north of Manor Farm, Barton Hartshorn and issues south-west of Garden Cottages, Barton Hartshorn	Moderate	Barton to Mixbury cutting	Groundwater flow to the springs and issue will be from the higher ground to the north which will not be disturbed by the cutting. Consequently no impact is expected to the springs. See Section 5.2 of this report for further discussion.	Negligible impact Neutral effect (Not significant)	None required	Negligible impact Neutral effect (Not significant)	None	None	Not applicable

5.2 Site specific assessments

Assessment of cuttings

Potential impacts from the Calvert cutting

5.2.1 A summary of the cutting details are provided in Table 10.

Table 10: Summary of Calvert cutting detailed groundwater assessment

Cutting parameters	Parameter details
Length (km)	4.15km
Maximum depth (m)	8.1m
Strata intercepted	Oxford Clay Formation (unproductive strata)
Lowest track level (m AOD)	82.1m AOD
Groundwater level(s) (m AOD)	No groundwater present

5.2.2 The Calvert cutting does not pass through any superficial deposits in this area. The bedrock geology comprises the Oxford Clay Formation which is classified as unproductive strata. The Calvert cutting in the area will be no more than 8.1m below the existing ground level and will not penetrate to within 10m of the base of the Oxford Clay. Borehole logs (British Geological Survey (BGS) 2013⁸) and the cross section shown on BGS G1:50,000 map sheet 219 (BGS, 2003⁹) indicate that the Oxford Clay is present to at least 25m below the ground surface.

5.2.3 There is a risk that leachate could be detected during construction in the vicinity of the Calvert landfill. This is discussed in Section 4.2 since surface water could be affected.

5.2.4 The Calvert cutting does not pass through any aquifers. There will therefore be no significant impact or effect on groundwater.

Potential impacts from the Twyford cutting

5.2.5 A summary of the cutting details are provided in Table 11.

Table 11: Summary of Twyford cutting detailed groundwater assessment

Cutting parameters	Parameter details
Length (km)	1.2km
Maximum depth (m)	4.8m
Strata intercepted	Oxford Clay Formation (unproductive strata)
Lowest track level (m AOD)	88.3m AOD
Groundwater level(s) (m AOD)	No groundwater present

⁸ British Geological Survey, BGS (2013). <http://mapapps.bgs.ac.uk/geologyofbritain/home.html?mode=boreholes>

⁹ BGS (2003). *Buckingham geological map*. Soil and drift map; Scale: 1:50,000, Sheet E219.

5.2.6 The Twyford cutting does not pass through any superficial deposits. The bedrock geology comprises the Oxford Clay Formation which is classified as unproductive strata. The Calvert cutting in CFA13 will be no more than 4.8m below the existing ground level and will not penetrate to within 10 m of the base of the Oxford Clay. Borehole logs (BGS, 2013) for the vicinity of the Twyford cutting indicate that the Oxford Clay is present to at least 23m below the ground surface.

5.2.7 As the Twyford cutting will not pass through any aquifers, there will be no impact or effect on groundwater.

Potential impacts from the Chetwode cutting

5.2.8 A summary of the cutting details are provided in Table 12.

Table 12: Summary of Chetwode cutting detailed groundwater assessment

Cutting parameters	Parameter details
Length (km)	1.95km
Maximum depth (m)	10.5m
Strata intercepted	Till (unproductive) Glaciofluvial sands and gravels (Secondary A aquifer) Peterborough Member of the Oxford Clay Formation (unproductive strata) Kellaways Formation (Secondary A aquifer)
Lowest track level (m AOD)	92.7m AOD
Groundwater level(s) (m AOD)	No groundwater level data available for the Glaciofluvial sands and gravels
Key receptors	Groundwater (Glaciofluvial Deposits and Kellaways Formation) One spring; located south-west of Rosehill Farm (180m south-west of route)

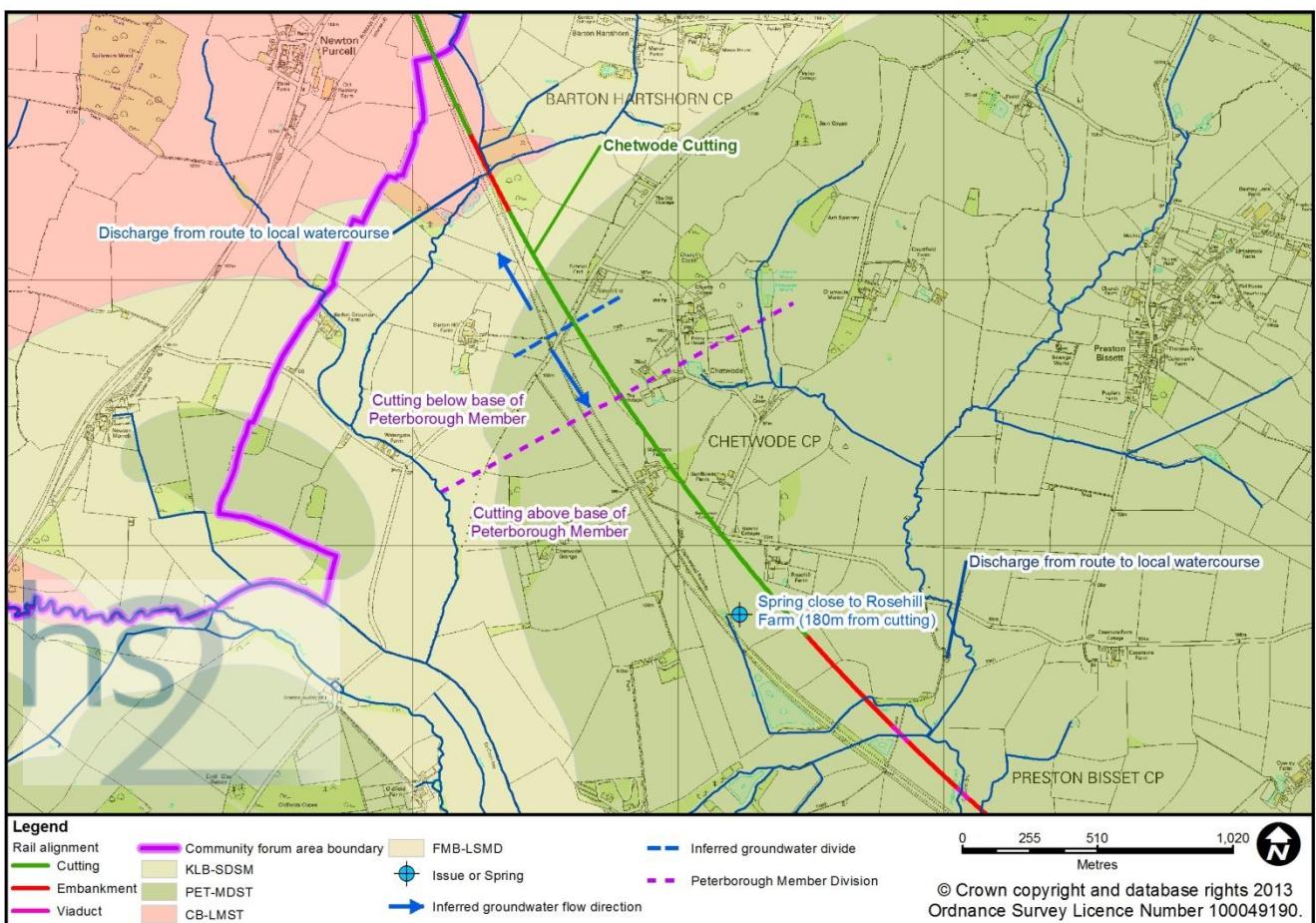
5.2.9 The Chetwode cutting passes through the Till and Glaciofluvial sands and gravels superficial deposits. The bedrock geology for the majority of the cutting comprises the Peterborough Member of the Oxford Clay Formation which is classified as unproductive strata. The cutting will be up to 10.5m below the existing ground level. The remainder of the cutting comprises Kellaways Formation as discussed below.

5.2.10 The geological map cross section (BGS, 2003) is located very close to the route of the Proposed Scheme. The section indicates that the base of the Peterborough Member is likely to be a maximum of 8m below the existing ground level in the vicinity of the cutting. Due to the regional dip of the strata, the Kellaways Formation, which lies below the Peterborough Member, is present directly below the superficial deposits over the northernmost zoom of the cutting. The absence of the Peterborough Member in the northernmost extent of the cutting, together with the details available from the geological

section, suggests that the Peterborough Member may be only 2-4m thick at Sunflower Farm, Chetwode, with the Kellaways Formation present below. For the majority of the cutting the Peterborough Member will be 6-8m in thickness.

5.2.11 The data available therefore indicates that the southern 1.2km of the cutting will be above the base of the Peterborough Member and the northern 750m will be below the Peterborough Member and within the Kellaways Formation. The possible elevation of the groundwater table has been inferred from the stream elevations and spring elevations within the vicinity of the watercourse crossings beyond the cutting. The topography and absence of a confining layer in the northern section of the cutting suggest there is likely to be a groundwater divide near Barton Hill Farm, with flow to the north and to the south either side of the divide (Figure 6).

Figure 6: Hydrogeological setting at Chetwode cutting¹⁰



5.2.12 The cutting will also pass through superficial Deposits which include the Glaciofluvial sands and gravels Secondary A aquifer, overlain by unproductive Till throughout the majority of the cutting. Any shallow groundwater present within the Glaciofluvial Deposits will be disturbed by the cutting although the Till which overlies the Glaciofluvial layer will tend to stop rainfall infiltrating into the Glaciofluvial Deposits to any significant degree. For the majority of the cutting the Glaciofluvial Deposits are considered to be perched

¹⁰ Key to geology legend – KLB-SDSM: Kellaways Formation – Sandstone, Siltstone and Mudstone, PET-MDST: Peterborough Member – Mudstone, CB-LMST: Cornbrash Formation – Limestone and FMB-LSMD: Forest Marble Formation – Limestone and Mudstone.

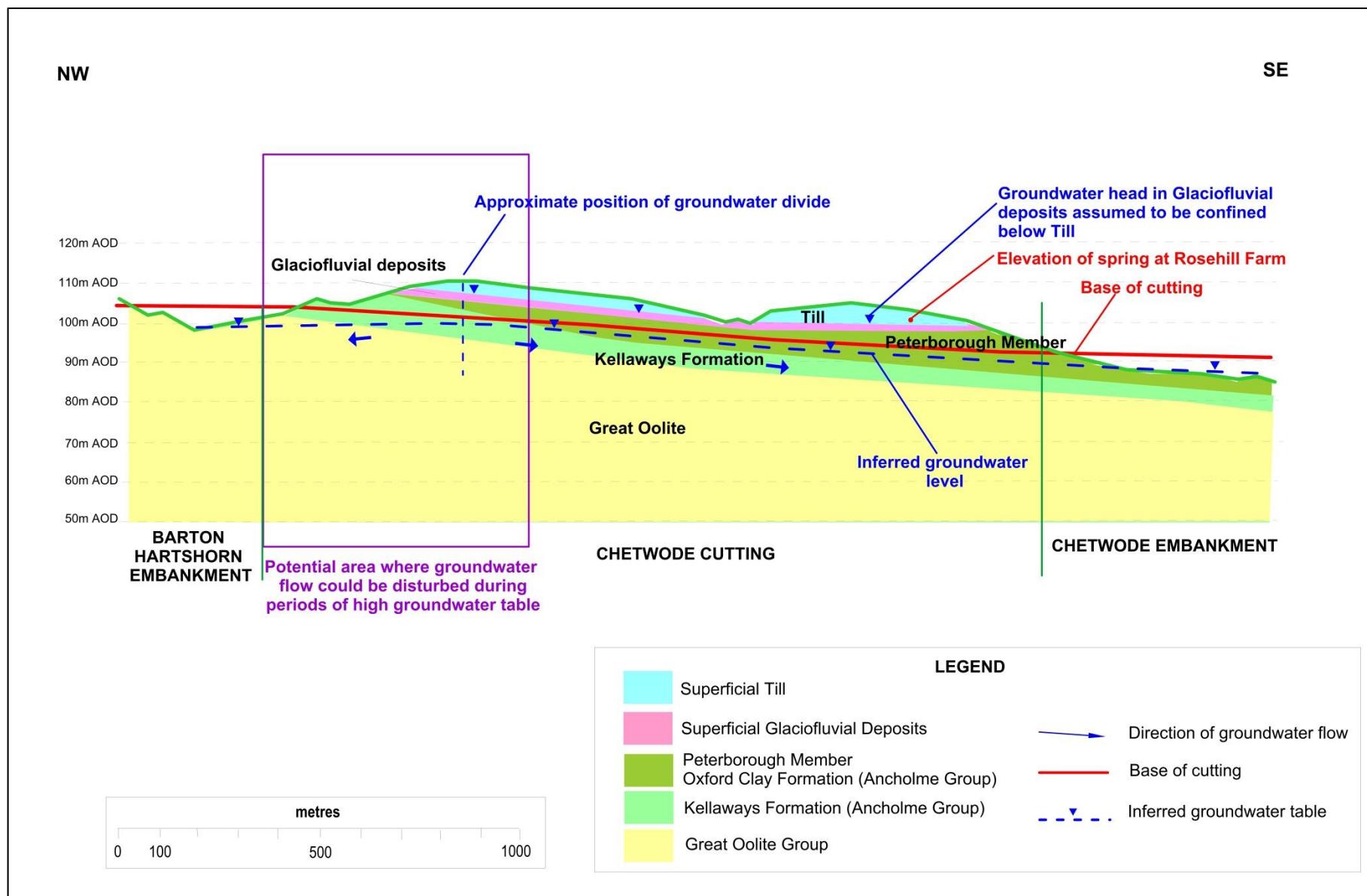
above the relatively impermeable Peterborough Member. For the northernmost 200m of the cutting the Peterborough Member is absent and the Glaciofluvial Deposits will be in hydraulic connectivity with the Kellaways Formation.

5.2.13 The data available indicate that there are no groundwater abstractions within 1km of the route.

5.2.14 The spring elevation at Rosehill Farm (180m south-west of the route) appears to be above the base of the Peterborough Member and does not appear to be within the superficial Glaciofluvial Deposits, which are absent at this location. It is likely that the spring is related to groundwater in the Glaciofluvial Deposits as the thickness of the Peterborough Member at this location is likely to be approximately 10m thick. The dismantled railway that runs parallel to the route, approximately 200m to the south-west of the cutting, is at a higher elevation than the spring and approximately 4m higher than the base of the Chetwode cutting will be at this location. As such, the cutting related to the dismantled railway would not have significantly affected the spring previously. Groundwater flow in the Glaciofluvial Deposits at the location of the spring can be inferred from topography to be from west to east, to the north of the spring and from north to south, parallel to the route, within the immediate vicinity of the spring. As such, the majority of flow to the spring will not be disrupted by the cutting. Although some groundwater flow may be disrupted by the route, there is considered to be sufficient contribution from flow to the north and west to feed the spring that there will not be a significant effect on the spring flow.

5.2.15 The inferred water table in the northern part of the cutting, where the Kellaways Formation is intersected, is likely to be below the base of the cutting (Figure 7). During periods of high groundwater elevations (following rainfall recharge), the groundwater table could rise enough to be slightly intercepted by the cutting. During such periods when the groundwater elevation is high there will be more water in the catchment to offset any effect from the cutting. Furthermore, track drainage to the north of Barton Hill Farm will be directed towards the north and the watercourse at Barton Hartshorn and so there will be no change in flows downstream of the cutting.

Figure 7: Inferred groundwater levels at Chetwode cutting



Potential impacts from the Barton to Mixbury cutting

5.2.16 A summary of the cutting details are provided in Table 13.

Table 13: Summary of Barton to Mixbury cutting detailed groundwater assessment

Cutting parameters	Parameter details
Length (km)	0.310 (in this CFA. This cutting also crosses into CFA14)
Maximum depth (m)	4.2m
Strata intercepted	Alluvium (Secondary A aquifer) Till (unproductive) Glaciofluvial Deposits (Secondary A aquifer), likely to be present below the Till Cornbrash Formation, Great Oolite Group (Secondary A aquifer)
Lowest track level (m AOD)	104.2m AOD
Groundwater level(s) (m AOD)	Alluvium – 0.6m below ground level (BGL) (BGS borehole log at Barton Hartshorn) No groundwater level data available for the Cornbrash Formation

5.2.17 The section of the Barton to Mixbury cutting in CFA13 passes through the Till (unproductive strata), potentially underlain by Glaciofluvial Deposits (Secondary A aquifer). The Till is present close to the boundary with CFA14. Some Alluvium is present along a tributary of the Padbury Brook. The bedrock geology for the section of the cutting in CFA13 comprises the Cornbrash Formation which is a Secondary A aquifer.

5.2.18 The cutting in CFA13 will be up to 4.2m below the existing ground level. Geological data available from the BGS (2003) indicates that in this CFA the cutting will pass through Till overlying Glaciofluvial Deposits which overly the Cornbrash Formation. The Cornbrash Formation is underlain by formations that comprise the Great Oolite aquifer system.

5.2.19 There are limited data available regarding groundwater elevations, although a BGS borehole log in the vicinity of Barton Hartshorn indicates that groundwater in the Alluvium is close to the surface, at 0.6m BGL, which is as expected owing to the proximity of the borehole in the Alluvium to the adjacent watercourse. There are no groundwater elevation data available for the Cornbrash Formation or the Glaciofluvial Deposits, although the Alluvium and Glaciofluvial Deposits are likely to be in hydraulic connectivity with the underlying Cornbrash Formation and similarly groundwater levels are anticipated in the Glaciofluvial Deposits, Alluvium and Cornbrash Formation.

5.2.20 There are no groundwater abstractions within 1km of the cutting in this CFA and therefore there will not be any artificial influence on the groundwater contours and flow directions.

5.2.21 There are a number of springs and issues in the vicinity of the cutting. These include the following sources which feed into tributaries of the Padbury Brook :

- issues located approximately 300m south-west of Garden Cottages in Barton Hartshorn; and
- springs located approximately 350m north of Manor Farm at Barton Hartshorn.

- 5.2.22 These issues and springs are on the opposite side of a small valley running parallel to the cutting which indicates that they are not supplied by groundwater from the cutting area.
- 5.2.23 Thus there will be no impact on these small local groundwater discharges from the cutting.
- 5.2.24 The route drainage will be designed to discharge to local watercourses in the vicinity of the cutting. Hence, any minor quantities of shallow groundwater which are intercepted by the cutting will continue to contribute to flows in local watercourses.

6 References

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